POWER PLANT ENGINEERING

Established Over 35 Years

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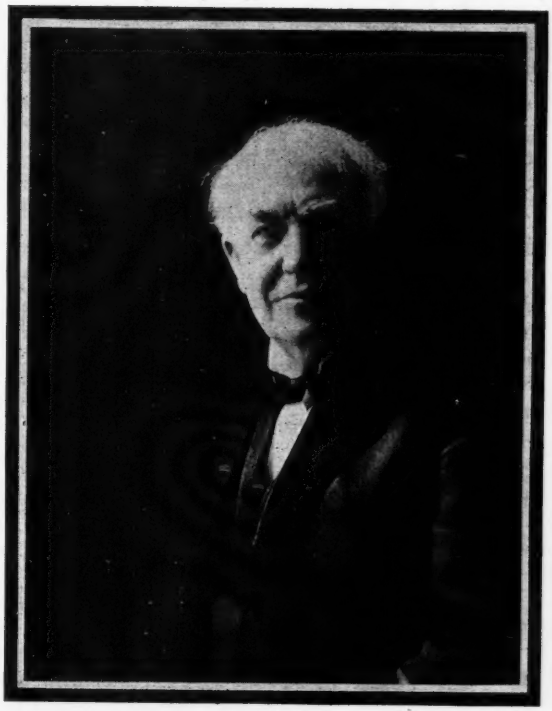


Thomas Alva Edison

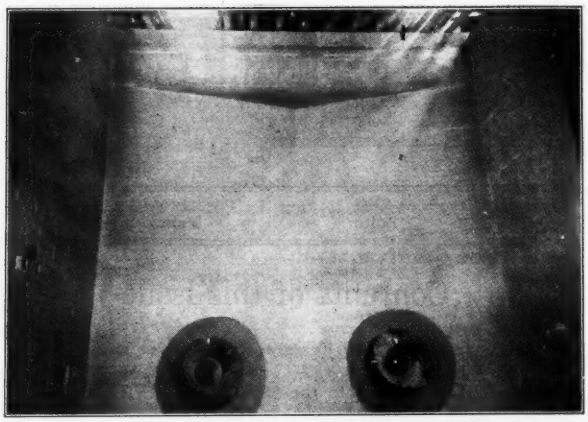
NO GREATER TRIBUTE could have been accorded Thomas Alva Edison upon the event of his death several weeks ago than that which was implied by the utter impossibility of carrying out a suggestion made in his honor. It had been suggested that the Electric Light and Power Companies of the nation cut off the power throughout the land for a period of one minute. This, however, could not be done. So great was the dependence of the nation upon the industry to which this man had contributed so much that even to honor him in the hour of his death the flow of power could not be interrupted for a single minute. Far more eloquent than words, this was a fitting tribute, indeed, for it was a true measure of the man's accomplishments.

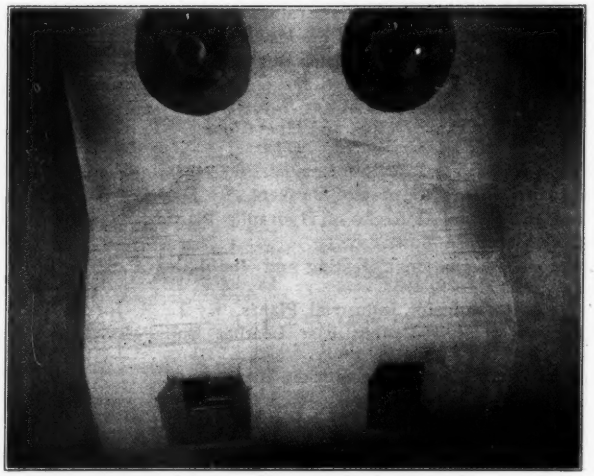
Whatever else Thomas Edison may have accomplished in his eventful career, the importance of his work in developing the electric light and power industry will always stand supreme. Not only was he responsible for the first successful incandescent lamp but he devised the first system by which a large number of incandescent lamps could be supplied from one source. It is because of the first successful development of a commercial lighting system more than anything else that the name of Thomas Edison will stand out among the immortals throughout all time.

Efficiency with Simplicity Features

New Power Plant

P. F. Glatfelter Co. builds new 350 lb. pulverized coil boiler plant for paper mill at Spring Grove, Pa.





By S. Blum
Philadelphia, Pa.

Mech. Engineer
H. M. Wilson Co.

MOST BOILER PLANTS have a way of tagging along with or behind an industry, being the last place where the management will make changes or improvements. We may truthfully say, however, that at the P. H. Glatfelter Co. paper mill at Spring Grove, Pa., the steam plant was born of the particular industry which it serves and to know the child, a knowledge of the parent is essential. For this reason it is well by way of introduction to give briefly a history and description of this modern and finely conducted paper mill.

Located in one of the finest parts of Pennsylvania. about ten miles from York, and just off what is today the Lincoln Highway, there operated at the time of the American Revolution, the pioneer iron bloomery west of the Susquehanna. The ore was found in nearby hills and charcoal derived from native woods furnished the fuel. The locality was then known as Spring Forge, and formed an important source of supply for the Continental Army. This iron industry thrived for about 85 yr.

In 1851 the forge buildings were converted into a paper mill by Jacob Hauer and, in 1863, in the midst of the Civil War and about the time Lincoln delivered his famous address at nearby Gettysburg, the place was purchased by P. H. Glatfelter, the grandsire of the present owner. The capacity, at that time about 1500 lb. per day, was gradually increased to 4000 lb. per day.

In 1874, the present mill was begun on a new site with one 82-in. machine and new equipment. Newspaper was the product at that time and the company had large box cars known as barns which were sent out over the railroads in charge of men who bought up straw of which the paper was made. Soon after, two other machines were added, followed by a 102-in. machine, the widest at that time. About 1880 the soda pulp plant was installed, the capacity reaching 60,000 lb. of newspaper per day.

Expansion in 1930 Made Additional Boiler Capacity Necessary

In 1895 the manufacture of newspaper was discontinued, the output then consisting entirely of good grade bond, writing and lithograph papers. In 1929, additional equipment and a 170-in. machine brought the capacity up to 108,000 lb. of paper daily. Each addition of equipment and buildings which had been made up to this time had evidently been carefully planned and laid out with a view to future development, so that from an efficient production standpoint, the mill is second to none. Great stress had at all times been put on maintenance, cleanliness and appearance and the general conditions prevailing would have delighted the heart of the most fastidious. The approach to the plant, the office building with its well kept grounds, the filter basin with its surroundings, were and are in perfect keeping with the conditions existing in every department.

In 1930 a building programme was set forth, with a view to adding 60 to 65 t. additional capacity daily, bringing the total output up to over 300,000 lb. of paper per day. A new 190-in. machine was installed, and to make way for the building extension to house this machine, the main line of the Western Maryland Railroad was shifted 45 ft.

Up to this time, steam was provided by seven 500 b.hp. Edge Moor boilers over Wetzel stokers and a 1000 b.hp. boiler over a Taylor stoker, giving a total of 4500 b.hp. Electric power was furnished by a 3750-kv-a. generator supplemented by purchased current. Boilers were provided with three Sturtevant cast iron economizers, arranged one for three boilers, one for four boilers, and

one for the large boiler. This boiler was equipped with a superheater and supplied steam direct to the turbine. The main boiler house was 22 yr. old, but the 1000-b.hp. boiler was not installed until 1923.

Normally, the plant had an output of 120,000 lb. of steam per hour with seven boilers operating at, or a little above, rating and burning 150 t. of coal daily or 12,600 lb. hourly, at an efficiency of 66 per cent. The hourly steam load after installing the new machines was to be 135,000 lb. normally, with 170,000-lb. peaks. There is no need to dwell in detail on the various methods which were considered for taking care of this increased load while at the same time securing an efficiency more in keeping with modern practice.

Limited Life of Old Boilers Favored New Equipment

Although the old boilers were still approved for 160 lb. pressure the knowledge that their life was limited, made it inadvisable to spend any great sum of money for combustion equipment. In addition, the possibility of using a back pressure turbine at some future date and the opportunity of securing greater economies from the present turbine which was designed for 300 lb. pressure, led to the choice of new boilers good for 365 lb. pressure with 125 deg. F. superheat. Two units were agreed upon to operate together normally to produce 75,000 lb. each at 200 per cent of rating, or in event of breakdown on either, the other to be capable of developing 135,000 lb. or 400 per cent of rating, until the 1000 b.hp. stokered boiler, which was retained and overhauled, could be brought into service.

New boilers are of the cross drum type built at the Walsh & Weidner Plant of the Combustion Engineering Corp. Each unit is rated at 1138 b.hp. 27 rows wide and 16 rows high, the lower rows arranged to form a slag screen. Foster convection superheaters having about 875 sq. ft. and capable of giving 125 deg. F. superheat, are located in the upper deck.

Choice of combustion equipment next lay between underfeed clinker grinder stokers and unit pulverizers. Limiting physical factors at the building such as depth because of existing sewers and the involved coal handling methods necessary because of the desire to retain the present 500-t. bunker and coal handling equipment finally led to the selection of pulverizers.

Unit Mills Placed in Basement

Each boiler was provided with two Riley Atritas rated at 7500 lb. of coal per hour, one unit being sufficient to carry a boiler at normal load. This provides ample capacity to carry each boiler at the maximum rating, at the same time giving a standby protection against breakdown at normal rating. Mills are placed in the basement, with the feeders on the firing floor directly in front of the burners. Over each feeder is a small hopper kept filled by a coal larry operating outside of the boiler room so as to avoid dirt and dust usually prevalent with coal handling.

When considering the question of additional economy to be secured from the installation of economizers, it was found that, taking into account the comparatively low exit gas temperatures guaranteed by the boiler manufacturers, the savings barely covered the carrying and operating costs on expensive economizer equipment. Cast iron economizers, installed by the B. F. Sturtevant Co. over 20 yr. before and designed for 250 lb. pressure, were still in good shape. Rather than scrap these a plan was worked out whereby they could be used in connection with the new plant. By arranging the feed piping so that only 125 lb. was carried on these economizers, there was every reason to expect many years of life from them. This was accomplished by building the boiler feed pumps in two units mounted on a common shaft; one unit, a two-stage machine, delivers the feedwater from the heater at 212 deg. F. to the economizers at 125 lb. and the second, a four-stage unit, boosts the pressure from 125 lb., 300 deg. F. from the economizer to 400 lb. for boiler feed.

With the new arrangement, one economizer which formerly served three small boilers was made to serve one of the new boilers. Results of a test given later, prove that the increased efficiency more than warranted the comparatively small expense of overhauling and installing this equipment.

Old Stack Accommodates New Boilers

For draft, each boiler is provided with a 90,000-c.f.m. capacity multivane induced draft fan, belt driven from a 100-hp. variable speed motor, controlled from the firing floor by means of a drum controller placed directly at the operating gage boards. These fans are designed to carry each boiler at 400 per cent rating when required. The fans discharge into a breeching which connects to the present brick chimney. This chimney 9 ft. 6 in. in dia. by 205 ft. high, was installed over 20 year ago by the Kellogg Co. and by cutting a new opening 4 ft. wide by 18 ft. high above the roof level, the cost of a

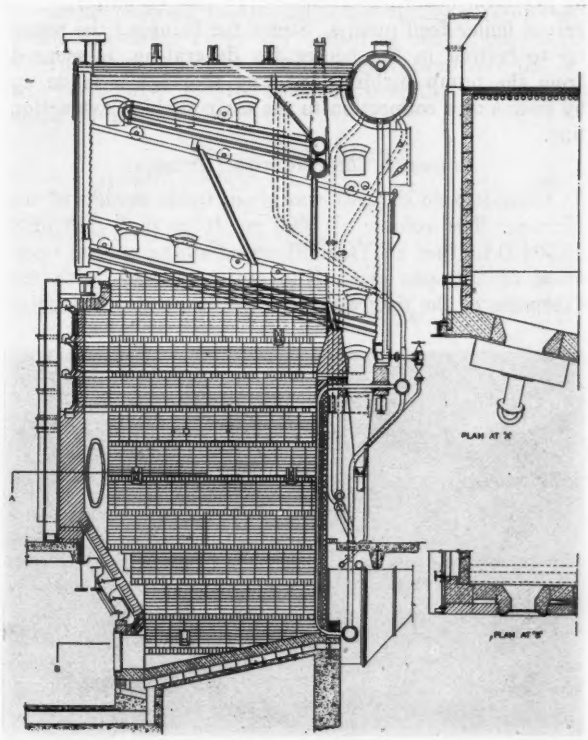


FIG. 1. SECTION OF THE BOILER

This with the two views in the headpiece shows the V-shaped front wall with the two burners arranged so the flames meet near the middle to avoid impinging on the sides. The lower photograph also shows the sloping portion of the wall over the ash removal doors. Because of the angles at which the surfaces meet the hollow wall design was difficult and complicated.

FIG. 2. MORE THAN USUAL CARE WAS TAKEN WITH THE EXTERIOR DESIGN

new chimney was saved. Air for combustion is furnished by two 53,000-c.f.m. turbovane motor driven forced draft fans discharging into a common air duct from which branches are taken to each of the new boilers as well as to the 1000-b.hp. boiler.

Water for boiler feed, about 25 to 30 per cent make-up, is secured from the mill filtration plant, passed through a zeolite softener, then the continuous blow down heat reclaimer, to a deaerating heater, from which it is delivered, free of hardness or corrosive oxygen, to the economizers and boilers by one of two turbine driven boiler feed pumps. Steam for bringing the water up to boiling in the heater for deaerating, is secured from the pump turbines and any shortage is made up by means of a connection to the main turbine extraction line.

Furnace Construction Unusual

Considerable thought was given to the design of the furnace. The volume of 6500 cu. ft. is such that only 13,500 B.t.u. per cu. ft. is liberated at the normal operation of 200 per cent. The entire furnace with the exception of the rear wall is of the suspended air-cooled

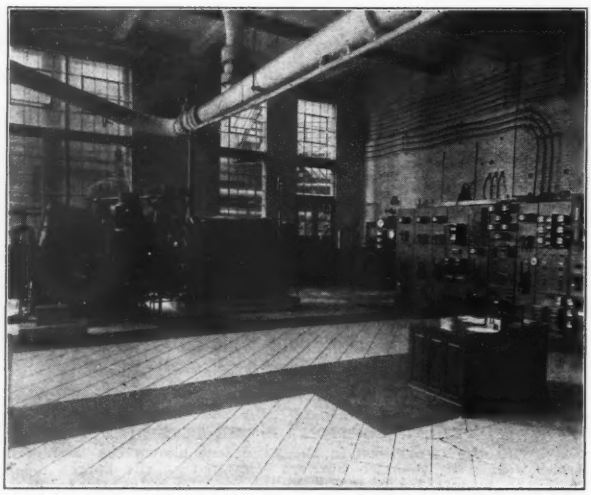


FIG. 3. CLEANLINESS AND ORDER THROUGHOUT THE MILL IS REFLECTED IN THE TURBINE ROOM

refractory construction. A water wall covers the rear surface. The requirement that the boilers be capable of operating at about 50 per cent of rating, or 500 b.hp. during week ends, made it inadvisable to use more water wall surface, since at low ratings in a large furnace the refractory surfaces were deemed necessary to assist in maintaining combustion.

It was decided to place the two burners side by side, so that both would be accessible from the firing floor level. To prevent impinging against the side walls of the furnace when operating only one burner, the flames are directed toward each other, so their center lines converge near the rear wall. This produced a V-shaped construction of the upper front, and this arrangement, coupled with the necessity of carrying the lower part of the front inward toward the rear of the furnace to secure space for ash handling in the basement, developed many difficulties in the design of the air-cooled construction.

Primary air, about 10 per cent of the total required for combustion, is drawn across the floor of the furnace,

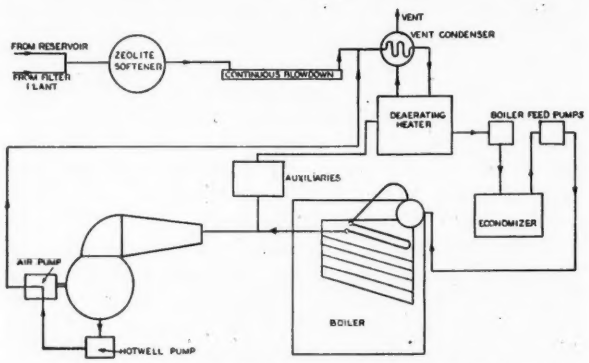


FIG. 4. FLOW DIAGRAM OF THE POWER PLANT

down the lower part of the front wall, through a duct under the basement floor to either or both of the pulverizers. Secondary air is passed through both side walls and the upper part of the front wall and is collected in the burner boxes. Air-cooled refractory walls are 9 in. thick with a 12-in. air passage and an exterior wall made up of ¼-in. asbestos millboard, 2-in. magnesia blocks and steel casing plates. This insulation has proven very effective, and the outside casing is cool to the touch after five days of continuous operation. The resulting air temperatures secured, while at the same time cooling and protecting the refractories, are given in the test summary. The rear water walls are of the Foster Wheeler C. I. wing back type, well insulated and provided with a steel casing.

One of the serious problems in connection with any pulverized coal plant is the catching and handling of the fine ash, particularly with a view to preventing it from going up and out of the chimney. Because of its fine dry condition, this material must be handled either absolutely dry or if wet it must be sluiced. In this case, a Nuveyor pneumatic system was used, and the material is handled dry at all times.

Ash Trapped in Many Places and Handled Dry

Provision is made to precipitate and collect the fly ash at various places along the gas travel, hoppers being provided at the last pass of the boiler, the economizers,

the breeching, and base of the stack. Each of these points is equipped with slide gates. Pipe connections convey the dry material to the main collecting pipe and on to a receiving tank for delivery to either trucks or cars. The required suction is provided by a steam ejector which produces a vacuum in a small receiving tank. The vacuum is broken intermittently by means of a motor operated timing valve, permitting the dry material to drop into the large collecting tank. Push button stations are placed at the various points along the piping system, so that the valve may be stopped and started with a minimum of walking on the part of the operator.

Combustion control apparatus has been reduced to the utmost simplicity, while at the same time making the operation as independent of the attendant as possible. Coal feed and secondary air supply are regulated to follow steam pressure, by means of a very sensitive electric pressure regulator, each boiler being equipped with a separate unit. The uptake dampers in turn are made to respond to furnace pressure.

To assist the operator further, all instruments such as flowmeters, draft gages, recording thermometers for steam, flue gas entering and leaving the economizer, CO_2 recorder, ammeters for both fans and pulverizers, are mounted on individual gage boards in front of each boiler. In addition, the drum controller for regulating the induced draft fan speed is also mounted at this gage board, along with emergency stop buttons for pulverizers and fans.

New Turbine Planned

As previously mentioned, equipment for the higher pressure was installed to accommodate a future back pressure turbine and the present extraction turbine which is designed for 300-lb. pressure. At present steam at 165 lb. to process is provided by means of a reducing valve set. This equipment consists of a Brooke Eng. Co. electric regulator and a Belfield balanced valve and the results produced by this combination are satisfactory under the most varying conditions.

Unfortunately the plant has to date had no occasion to operate on pressures in excess of 200 lb., so that no results for checking the manufacturers' guarantees

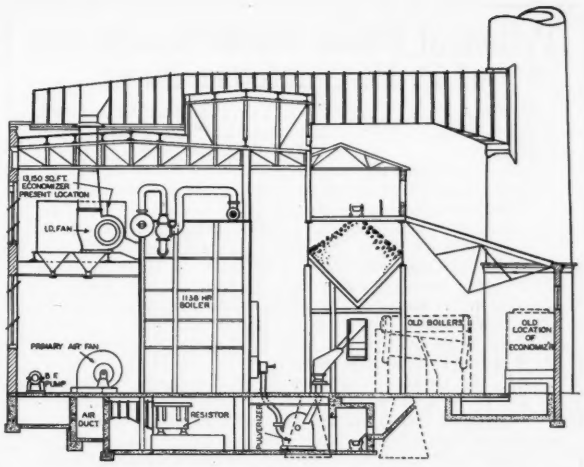


FIG. 6. IN THE NEW PLANT THE OLD LOW PRESSURE ECONOMIZERS WERE ARRANGED TO SERVE THE NEW BOILERS

have been secured. Six months of operation under the above conditions has shown most gratifying results and a careful inspection of equipment after this period proved conclusively the advantage to be gained by liberally proportioning furnaces and other equipment. The refractories were in perfect condition and gave promise of requiring little repairs for a long time to come. The working parts of the pulverizers betrayed only a high polish and no perceptible wear after pulverizing approximately 4500 t. of coal.

Accompanying results, obtained during a recent test conducted under every day operating conditions, would approximate closely the average operation over the entire period of 6 mo., the efficiency over this period averaging 87 per cent.

Boiler Test Result

Water Evaporated per hour, lbs.	68,700
Builders Rating, b. hp.	1,138
Developed, b. hp.	2,390
Percentage of Rating developed, %	211
Coal, as fired, lb. per hr.	6,253
Coal, dry basis, lb. per hr.	6,225
Water evaporated, lb. per lb. of coal as fired	10.95
Water evaporated, lb. per lb. of coal, dry basis	11.0

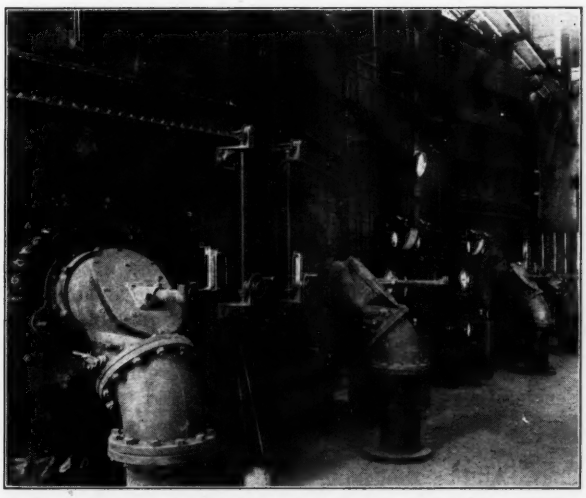


FIG. 5. BOILER FRONTS SHOWING THE V-SHAPED FRONT WALL AND COMPLETE CONTROL PANELS

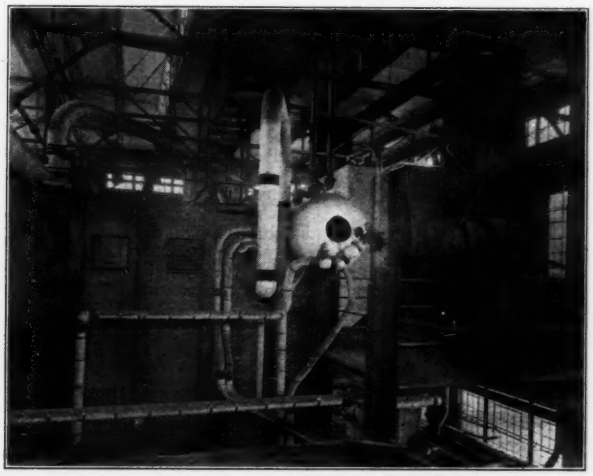


FIG. 7. ECONOMIZERS AND INDUCED DRAFT FANS ARE LOCATED ON A PLATFORM DIRECTLY BEHIND THE BOILERS

Principal Boiler Room Equipment of P. H. Glatfelter Plant

Location.....Spring Grove, Pa.
Building.....Steel frame, concrete floors, brick walls
Service.....Industrial process and power
Total steam capacity, max.....200,000 lb. per hr.
Engineers and Constructors.....H. M. Wilson Co.
2—Combustion Engineering Corp. Walsh & Weidner straight tube, sectional header, cross drum, 365 lb. ga. pressure Type S boilers. Drums 54 in. dia., 23 ft. 0 in. long, 432 tubes 4 in. dia., 22 ft. 0 in. long, 27 tubes wide, 16 tubes high, rated 1138 b.hp. each.
2—Foster Wheeler Corp. convection superheaters, 875 sq. ft. each
2—Foster Wheeler Corp. 290 sq. ft. (32-3¼-in. tubes) C. I. wing back water walls
2—M. H. Detrick Co. 6900-cu. ft. furnaces with 1000 sq. ft. of hollow suspended refractory side and front walls and 200 sq. ft. of air-cooled refactory floor
4—Riley Stoker Corp. No. 5 Atritas, two for each boiler. Each mill rated at 7500 lb. per hr., driven by a 100 hp. Westinghouse motor
4—Riley Stoker Corp. No. 5 turbulent type burners
2—B. F. Sturtevant Co. cast iron economizers, 13,150 sq. ft. each
2—B. F. Sturtevant Co. No. 11, Design No. 3, single width, induced draft fans, 90,000 c.f.m. 375 deg. gas, 5 in. static pressure. Driven by 100-hp. variable speed Westinghouse motors
2—B. F. Sturtevant Co. No. 95, Design No. 6, double width, forced draft fans, 53,000 c.f.m., 5½ in. static pressure. Driven by 75 hp. Westinghouse motors
1—Cochrane Corp. C. I. deaerating type heater—capacity 156,000 lb. per hr.
1—Permutit Co. Zeolite water softener, capacity 240,000 gal. between regenerations
1—Permutit Co. continuous blowdown for three boilers
2—Frederick Steam Pump Co. boiler feedwater pumps, each consisting of two pumps; one 4-in., two-stage for 400 g.p.m. at 115 lb. from heater to economizer and one 4-in., four-stage for 400 g.p.m. at 400 lb. from economizer to boilers. Driven by 150-hp. Terry turbines
2—Northern Equipment Co. Copes feedwater regulators
2—Elliott Co. Lagonda stop check valves
2—Engineer Co. balanced draft combustion control
2—Brooke Engineering Co. electric pressure regulators
2—Bailey Meter Co. air flow-steam flow boiler meters
2—Hays Corp. CO_2 recorders
2—Bailey Meter Co. four-pointer draft gages
4—Westinghouse Electric & Mfg. Co. ammeters
2—Brown Instrument Co. steam temperature recorders
2—Brown Instrument Co. 2 pen flue gas temperature recorders
1—Brown Instrument Co. 2 pen feedwater temperature recorder
1—Brown Instrument Co. 2 pen pressure recorder
14—Brown Instrument Co. electric steam flowmeters
1—Brooke Engineering Co. and H. Belfield Co. 10 in., 350 lb. to 165 lb. combination balanced reducing valve and electric pressure regulator
1—R. H. Beaumont Co. and Link-Belt Co. (existing) coal handling equipment, consisting of yard storage of about 6000 t. with track hopper, elevator and drag scraper. Also a flight conveyor to a 500-t. suspended inside bunker. Each pulverizer has a 2-t. hopper filled by a weigh larry
1—United Conveyor Corp. Nuveyor ash and soot handling system
1—M. W. Kellogg Co. radial brick stack, 9 ft. 6 in. dia. by 205 ft high
Valves.....Lunkenheimer Co.
Traps.....Strong, Carlisle & Hammond
Piping.....Standard Piping & Fitting Co.
Steel fittings.....Reading Steel Casting Co.
Covering.....Ehret Magnesia Co.
Soot blowers.....Diamond Power Specialty Corp.
Water columns.....Yarnall-Waring Co.
Blowoff valves.....Yarnall-Waring Co.
1—General Electric Co., 3000-kw., 550-v., 3-ph., 60-cycle generator driven by a four stage condensing extraction turbine
1—General Electric Co., 25-kw. dual drive exciter set
1—Foster Wheeler Co. surface condenser with auxiliaries
1—General Electric Co. 20-panel black slate switchboard

Equivalent evaporation, lb. per lb. dry coal boiler and economizer	13.21
Boiler only	12.5
Efficiency of boiler and economizer, %	89.1
Efficiency of boiler, %	84.2
Power for coal pulverizing, kw. hr. per t.	17.4
Cost at 1c per kw. hr.	0.174
Steam pressure, lb. ga.	150
Total Temperature, deg. F.	498
Superheat, deg. F.	132
Water entering blowoff reclaimer, deg. F.	49
Water leaving reclaimer,—entering reheater, deg. F.	59
Water blowdown, deg. F.	78
Water leaving f.w. heater, deg. F.	133
Water entering economizers, deg. F.	129
Water leaving economizers, deg. F.	197
Air in building, deg. F.	76
Secondary air entering burners, deg. F.	142
Primary air entering pulverizers, deg. F.	210
Gases leaving boiler,—entering economizer, deg. F.	444
Gases leaving economizer, deg. F.	299
Blowdown, %	1.82
Concentration of blowdown, deg. Baumé	0.325
Makeup Water, %	44
Heat Released, B.t.u. per cu. ft. of Furnace Volume per hour	13,700
Secondary air pressure entering walls, in.	+2.6
Secondary air pressure above burners, in.	+1.8
Secondary air pressure at burners, in.	+ .74
Draft, furnace, in.	— .25
Draft, uptake, in.	— .34
Draft, leaving economizer, in.	— .92
Electric power for pulverizing, hp.	69.5
Electric power for induced draft, hp.	57.5

The coal burned is a Pennsylvania Bituminous, of the following approximate analysis in per cent: Moisture, 0.53; volatile, 17.90; carbon, 73.57; ash, 8.00; B.t.u. dry basis, 14,320; temp. fusing of ash, 2730. Average fineness of pulverization is 85 per cent through 200 mesh.

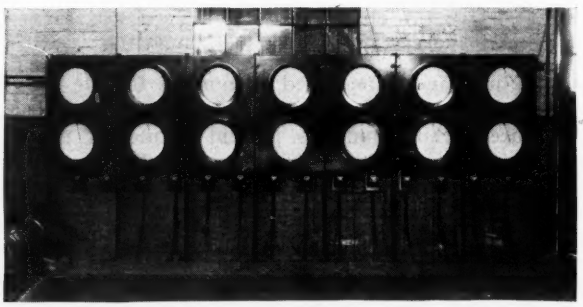


FIG. 8. ELECTRIC FLOWMETERS MEASURE ALL STEAM

Efficiency of the plant should not be difficult to maintain since recording instruments have been provided to detect any deficiencies. Complete logs of operation are kept, and these, along with recorder charts, are carefully analyzed each day. Steam to every department in the plant is also metered, instruments being of the electric type, mounted on a common gage board, located in the turbine room. In this way, a complete accounting of power and steam is available at all times, assisting in cost distribution and making possible a close check on the operation of these various departments.

The plant still purchases power from the Public Service Co., the generator being arranged to make current to the extent of extraction steam requirements, the machine being paralleled with the service company's lines. At this time approximately 60 per cent of the current is made, while the remaining 40 per cent is purchased.

Turbine Performance *from the* Mollier Diagram

In Heat Balance Calculations, a Knowledge of and Familiarity with the Turbine Expansion Line is a Necessity

PROBABLY THE MOST interesting and valuable phase of power plant study, for the modern and practical power plant engineer, lies in investigations and analysis of the prime movers from the total heat-entropy chart or, as it is commonly called, the Mollier Diagram. The pressure-volume diagram or conventional indicator card is of value in studying engine performance; the temperature-entropy diagram is of value in studying different cycles but it is from the Mollier diagram that modern turbine heat balance studies are best made.

Pressures, volumes and temperatures are familiar to all engineers but unfortunately entropy, which cannot be visualized, remains more or less of a mystery. Many attempts have been made to explain this term in simple non-mathematical terms, so that it could be visualized, with indifferent success. Expressed mathematically, it is usually written

$$dE = dH \div T$$

where

dE = Change in entropy
dH = change in heat
T = absolute temperature

Entropy is tabulated in the steam tables with specific volumes, total heats and other quantities and it is perhaps well for the beginner to take it for granted, remembering only that adiabatic expansion takes place at constant entropy, that is vertically on a total heat-entropy or temperature entropy chart. Adiabatic expansion of steam means that the steam expands in the turbine or engine cylinder without receiving, or losing, any energy in the form of heat to or from an outside source. All the heat change is converted into mechanical work. When it is remembered that the ideal engine and turbine operate with adiabatic expansion, the importance and convenience of entropy in simplifying calculations

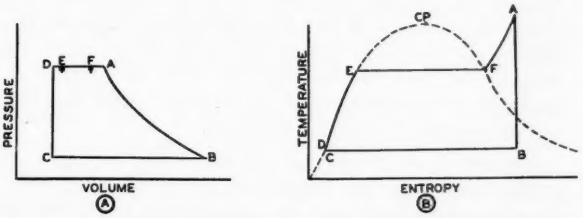


FIG. 2. A. RANKINE CYCLE ON PRESSURE VOLUME COORDINATES B. THE SAME CYCLE ON TEMPERATURE-ENTROPY AXES

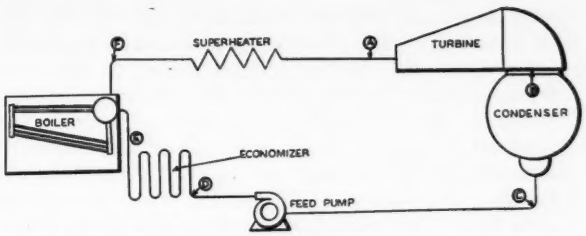


FIG. 1. DIAGRAMMATIC REPRESENTATION OF A SIMPLE STEAM PLANT

should be apparent. If it is not, a few practical calculations will soon demonstrate its usefulness and a working familiarity with this abstract quantity will be gained.

Other Diagrams

In order to correlate this diagram with the more familiar pressure-volume and temperature-entropy diagrams, a simple steam plant as represented by Fig. 1 has been assumed. Figure 2A is a typical pressure-volume or conventional indicator diagram while Fig. 2B is the same cycle plotted to different coördinates; lettered points on each diagram refer to similarly lettered points in Fig. 1. For assumed conditions, these diagrams could be drawn to scale from quantities taken directly from the steam tables. This has not been done in Fig. 2 because, for the conditions to be covered in this article, the scale would be such that the diagrams would be distorted from their conventional representation as shown.

In Fig. 3, however, the diagram transferred to a Mollier chart is drawn to scale for conditions of 650 lb. abs., 750 deg. F. and 1 in. abs. condenser pressure. No feedwater heating is used and line losses and hotwell depression are neglected in this theoretical diagram, which is merely an introduction to the practical application of the chart.

Beginning the cycle at A, steam is expanded in the turbine adiabatically along the line A-B; condensed in the turbine isothermally along the line B-C; the pressure is increased at constant temperature in the feed pump along the line CD; the temperature and heat content is increased at constant pressure in the steaming economizer along the line DE; in the boiler the water

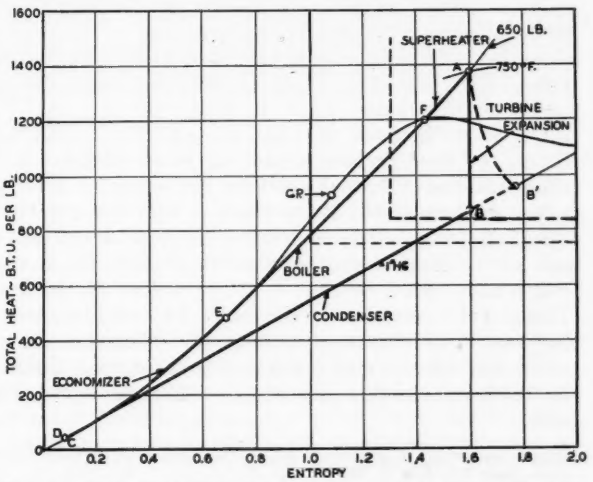


FIG. 3. COMPLETE STEAM CYCLE ON A MOLLIER DIAGRAM

is vaporized, at constant pressure along the line EF and superheated, also at constant pressure, in the superheater along the line FA. This refers to all three diagrams, Figs. 2A, 2B and 3. Note that the increase in pressure across the feed pump does not increase the temperature, heat content or entropy in measurable quantities so that in Figs. 2B and 3 points C and D coincide.

In Fig. 1, a steaming economizer, that is an economizer in which the feedwater is heated to the saturation temperature, has been assumed because it allows the point E to be definitely located on Fig. 3 at the point where the 650-lb. line joins the liquid line between the origin of the chart and the point labeled CP, or critical point, at 3226 lb. abs., 706.1 deg. F. At the critical

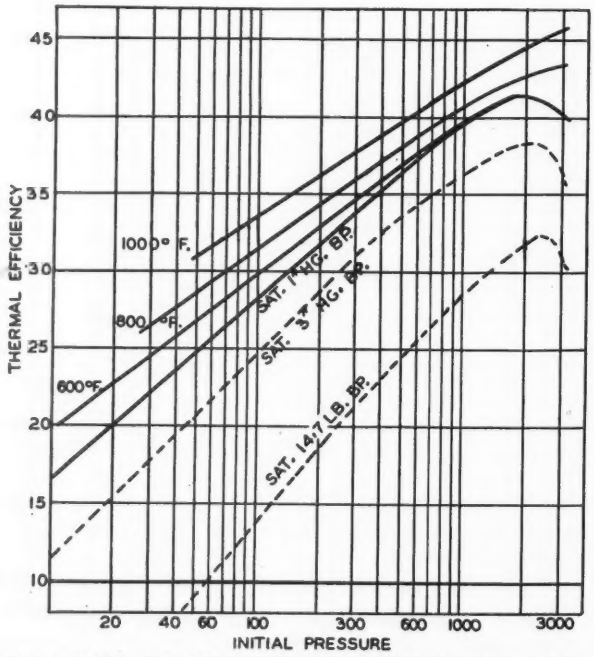


FIG. 4. VARIATION OF RANKINE CYCLE EFFICIENCY WITH PRESSURE TEMPERATURE AND BACK PRESSURE

point the latent heat of vaporization is zero.[1] The greater portion of the Mollier diagram is not commonly used. Its use is confined largely to the upper right-hand portion where the light dotted lines show the part included in the new A. S. M. E. chart.

Referring to Fig. 3, the heat content of a pound of water at C (79.06 deg. F.) is 47.06 B.t.u. As the steam leaves the superheater at A the heat content is 1377.75 B.t.u. or an increase of (1377.75 — 47.06 =) 1330.69 B.t.u. An ideal turbine expanding steam adiabatically along the line AB would exhaust the steam at B with a heat content of 861 B.t.u. That is 1377.75 — 861 = 516.75 B.t.u. would be converted into mechanical work and as a horsepower is equivalent to 2543 B.t.u. the water rate would be 2543 ÷ 516.75 = 4.93 lb. per hp. This calculation makes no allowance for radiation, bearing loss, blade efficiency[2] or generator efficiency. As in every case efficiency of a machine is the output divided by the input, in this case 516.75 ÷ 1330.69 = 38.8 per cent.

[1]See Power Plant Engineering, Steam Generation at Critical Pressure, page 718, July 1, 1928.
[2]See Power Plant Engineering, Draining Moisture from Turbines, page 970, Oct. 1, 1931.

In general terms, this efficiency, which is the thermal efficiency of the Rankine cycle, can be calculated from the formula

$$E = \frac{H_A - H_B}{H_A - H_C}$$

where

E = thermal efficiency of Rankine cycle
H_A = total heat at turbine throttle, B.t.u. per lb.
H_B = total heat at turbine exhaust, B.t.u. per lb.
H_C = heat of liquid leaving condenser, B.t.u. per lb.

All of these quantities can be conveniently taken from a Mollier chart.

It is evident that this efficiency will vary with the initial temperature and pressure and with the back pressure. Figure 4 shows the variation graphically for 1 in. abs. condenser pressure and various temperatures. Dotted lines show how the increasing back pressure decreases the efficiency (for saturated steam only). Increased initial temperature with these other higher back pressures will cause approximately the same percentage increase as for 1 in. abs. back pressure as indicated by solid lines.

Unfortunately an actual turbine is not able to convert all of the available heat drop AB into work. In practice the expansion line slopes to the right as does line AB′, the slope being steeper in the superheated than in the saturated region. If the heat content of the exhaust at B′ is 950 B.t.u. the actual cycle or thermal efficiency is then (1377.75 — 950) ÷ (1377.75 — 47.06) = 427.75 ÷ 1330.69, or 31.1 per cent instead of 38.8 per cent as in the ideal turbine. That is, the real turbine is but (31.1 ÷ 38.8 or) 80.1 per cent as efficient as the ideal turbine.

Efficiency given by Eq. 1 is the thermal efficiency of the Rankine cycle as represented by Figs. 2 and 3. This efficiency has little meaning when applied to real turbines. From Fig. 4 it is seen that with 100 lb. pressure saturated steam the maximum efficiency of a turbine would be 28.5 per cent while with 1000 lb. saturated steam the maximum ideal efficiency would be over 10 per cent higher. In order to have thermal efficiency mean anything in a relative way, the temperature, pressure and back pressure would have to be stated also. To obviate this additional complication, turbine efficiency is usually expressed as the Rankine (cycle) Ratio, that is, the ratio of the efficiency of the real turbine to that of an ideal turbine operating between the same limits. For the limits in Fig. 3, this would be 31.1 ÷ 38.8, or 80.1 per cent as mentioned above, or directly from a Mollier diagram as

$$\text{Rankine Ratio} = \frac{H_A - H_B'}{H_A - H_B}$$

Where H_A, H_B and H_B' are total heat contents of the steam at points A, B and B′ respectively. The Rankine Ratio (efficiency) is simply the ratio of the heat drop actually utilized to the adiabatic heat drop, that is a measure of the efficiency of the turbine blades and bearing no relation to thermal efficiency.

Inasmuch as the heat drop $H_A - H_B$ (or $H_A - H_B'$ as the case may be) represents the heat taken out of the steam and converted into mechanical work, the heat change $H_B - H_C$ (or $H_B' - H_C$) represents the heat loss to the condenser. If this heat ordinarily lost to the

condenser, could be saved, the efficiency of the steam plant could be tripled. In an industrial plant using the exhaust steam, this heat is reclaimed and, neglecting radiation losses, the cycle of efficiency closely approaches 100 per cent.

Benson Boiler of 7300 Hp.

FOURTH INSTALLATION IS AT LANGERBRUGGE FOR 220,400 LB. STEAM AN HOUR DELIVERED AT 2845 LB. AND 842 DEG. F.

AT THE MEETING of the International Congress of Mechanics, M. Leopold Herry of the Central Electric Society of Flanders gave some interesting figures on the latest installation of a Benson boiler at Langerbrugge, the design being based on experience with plants installed at Rugby, England, and at Siemenstadt near Berlin.

Steam is generated at 3220 lb. per sq. in. absolute and at 705 deg. F. at the rating of 220,400 lb. an hour with continuous overload capacity of 250,000 lb. an hour and of 270,000 lb. an hour for ½ hr. It is supplied to the high-pressure turbine through a reducing valve at 2845 lb. and 842 deg. F., expanded to 853 lb. and 617 deg. F., returned to the boiler for reheat to 842 deg. at 796 lb. and reaches the lower-pressure turbine at 711 lb. pressure.

In steam generation, distilled water, heated to 365 deg. F. by bled steam is pumped, under 3556 lb. pressure, to an economizer from which it passes to the evaporating section and the superheater section. Heating surface is arranged about a square furnace, with two economizers and reheaters outside, on opposite sides. Furnace walls have 5404 sq. ft., economizers 9392 sq. ft. and reheaters 6813 sq. ft. of surface. Air is preheated to 752 deg. F. in an air heater of 23,682 sq. ft. surface, air circulation being forced through the hollow walls and the air heater by two fans.

WATER CIRCULATION

Passage of water and steam through the sections is such as to take greatest advantage of heat transfer. Each economizer section is divided into two parts, arranged one below, the other above a reheater section. Twenty-four coils, each have four circuits of 13/16-in. tubes in parallel. From the top of the economizers water passes to the bottom of the upper half of the furnace walls, which have the 28 rows of parallel tubes in a spiraled arrangement around a square furnace to secure uniform absorption of heat. From the top of this section, steam flows to the top of the lower half of the walls and passes downward through 28 rows of tubes to become superheated. As steam and water are at the same temperature, there is no formation of steam bubbles and no steam drum is used, the steam flowing as required directly from the evaporating tubes to the superheating tubes, then through the reducing outlet valve to the steam main.

Because there is no steam storage space, the supply of fuel, air and water must be regulated together and within close limits, which is controlled from a central point by push buttons operated by a single handle according to steam demand. Excess pressure is relieved by five safety valves, two of which are spare capacity, each able to discharge 50 t. of steam an hour.

Feedwater is handled by a 19-stage centrifugal pump which requires 2320 hp. to drive it at full capacity. Water enters the suction at 95 deg. F. under 16½ ft. head, is passed at 850 to 925 lb. pressure through feedwater heaters between stages and delivered to the economizers at 356 deg. F. under 3556 lb. pressure. A spare pump unit of the same capacity and arrangement is provided. Drive is by reduction gearing from a 4000-kw. turbine unit with a synchronous motor connected, which can act as a generator to deliver power when the turbine is operating at full capacity, or can assist in driving the pump when the turbine is delivering less power than that needed to drive the pump. Also a 1500-kw. turbine unit for 711-lb. steam may be used instead of the motor for helping out the high-pressure turbine, as power from that turbine at low boiler loads is insufficient to drive the pump and the deficiency must be made up from the 25,000-kw. low-pressure unit, which utilizes the exhaust from the high-pressure unit, or from the auxiliary turbine. If neither motor nor auxiliary turbine is available, a bypass on the 4000-kw. unit enables it to develop power to drive the pump.

Thermal efficiency is expected of 87 per cent for the boiler, which occupies a rectangular space in the open 49 ft. 3 in. by 39 ft. 8 in. and 106 ft. 6 in. high. Above this is a stack 41 ft. high, making the total height of the unit 147 ft. 6 in. Eight down-shoot burners for pulverized coal or coke are used, with two burners each for coal and gas to give ignition when starting the unit.

A Trainload of Circuit Breaker Tanks

THE CRATES and cases shown on the 14 freight cars in the accompanying photograph contain tanks for only one-half of the twenty 161,000-v. General Electric oil

circuit breakers for the Dneiper River project, U. S. S. R A total of 50 freight cars was required to transport the 20 oil circuit breakers from the G. E. plant at Philadelphia, Pa., to the seacoast for shipment. Each of the breakers weighs 50 tons installed. This includes the oil, which amounts to approximately 6600 gal. for each breaker.

INTERESTING as a side light on why compromises are necessary in machine design is the statement by Dr. Elihu Thomson that the use of a spherical armature for early Thomson-Houston arc light dynamos was because both ring and cylinderical armatures were covered by patents and the spherical was the only form left available.

Economics of Engineering

By WM. S. MONROE*

Engineering May Be Regarded as a Branch of Economics, an Understanding of Which Is Incumbent Upon the Engineer

AMONG THE THINGS that the present economic condition will force us to realize is that the protection of the future value of an investment during its years of useful life is a responsibility of the engineer, as well as of the financier and economist. This is a speculative phase of the enterprise which we as engineers hesitate to attack, for it involves predictions as to future developments, which, in this rapidly changing world are, of course, difficult to make.

After all, in the broader sense of the terms, is not engineering just one branch of the general subject of economics? The dictionary defines economics as "The science that investigates the conditions and laws affecting the production, distribution and consumption of wealth, or the material means of satisfying human desires." Certainly, engineering is a large factor in the "production and distribution" of wealth, if not in its consumption, and it has a most important influence on the "means of satisfying human desires."

Newspaper and magazine writers of the day are wont to say that we are living in a scientific and engineering age, which is undoubtedly true, but it is not so much emphasized that we are living in a commercial age. There are few enterprises today that do not have to stand the "dollar test" and earn "a return" on investment. Only a few years ago, most of our power stations and office buildings and many factories were made monumental in character, but today, the utilitarian and functional aspects are far more dominant. They will become increasingly so, and fixed charges on the investment in relation to earning power are going to be more closely scrutinized. The more advanced architects are beginning to realize that it is possible to house the economic and industrial requirements of an enterprise in a building of fine proportions and graceful lines, and with simple, straight-forward decorations, without sacrificing any of the utilitarian requirements.

From a practical point of view, the economics of engineering become largely a matter of recognizing the importance which the "fixed charges on the investment" bear to the ultimate value of the enterprise. In the industrial activities of the day, as methods of production become more refined—whether it be manufacturing processes or the production and distribution of electric power—the investment in plant and equipment becomes an increasing factor in the cost of the finished product. In manufacturing, our methods of quantity production have reduced the cost of raw materials and labor, but have increased the cost of plant and the consequent items of fixed charges. In our electric power stations, as our technical knowledge and experience have improved, we have considerably reduced the cost of fuel and labor, but it has been very difficult greatly to reduce the fixed charges because the cost of the more elaborate and refined technical equipment has nearly offset the reduction in costs that could be effected by the increasing size of units and by reduction in building requirements per unit of capacity.

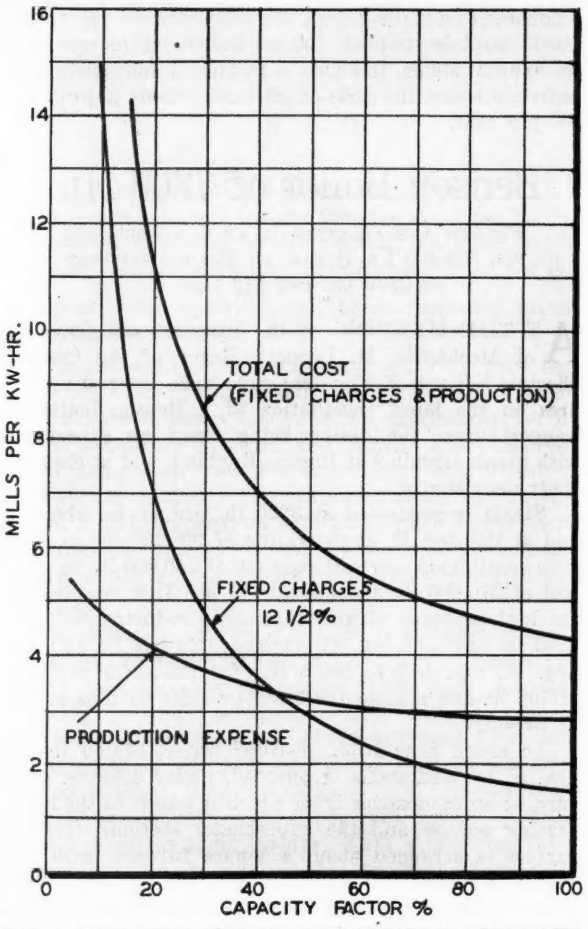


FIG. 1. VARIATION OF POWER GENERATING COST WITH CAPACITY FACTOR

In this connection, I am going to put before you a diagram, Fig. 1, which is made to show the cost of electric power per kilowatt-hour of output for different capacity factors at a prominent modern power station. The lowest curve indicates the production costs, including fuel and labor; the intermediate curve, the fixed charges on investment; and the top curve is the total of the other two. You will see what a large factor the fixed charges are. At any average capacity factor up to about 45 per cent, the fixed charges are a larger item than the production costs. The production costs per unit of output are fairly uniform, but the fixed charges per unit are nearly half of the total at the high capacity factors

*President Sargent & Lundy, Inc., Chicago, Ill., abstracted from a paper presented at the Great Lakes Division of the N.E.L.A. meeting at French Lick Springs, Ind., October 2.

and mount up extremely high at the lower capacity factors. At another station, at which the cost of fuel is considerably lower, the fixed charges have a still higher percentage of the total. The curve which shows the relation of fixed charges to capacity factor applies in general form to all other investments in which your companies are interested, as much as to power stations. It is well to keep the form of that curve in mind. It shows that one way to keep down the fixed charges per unit of output is to make the investment work as many hours out of the year as possible. It emphasizes the desirability of increasing the load factor on the company's system, by getting more off-peak load. As an example, studies of electric heating during the past few years have developed the fact that given a low rate for off-peak energy, houses and other buildings can be economically heated by electricity, using it only at night, and with perfect regulation and absolute cleanliness. There are many ways of developing the use of off-peak energy in industry and increasing attention must be given to that subject.

Figure 2 shows the effect of the life of the plant on fixed charges. It is the ordinary amortization diagram showing the amount of annual deposit that would be required to equal a capital investment of $1000 in a varying number of years and at different rates of interest. Of course, the annual deposit becomes rapidly less as the years of life increase, but the diagram also shows that if a short life is to be assumed for the investment, interest rates have less percentage effect on the annual amortization than when the life is to be fairly long.

These diagrams bring to your attention the two things which, fundamentally, most affect fixed charges on any investment—the life of the plant or equipment, and the use factor, or as we call it in connection with power stations, the capacity factor. Admittedly, these two things are both difficult to predict in advance, especially, the life of the plant, but that does not make them any less important and it is my belief that they will from now on have to be given careful consideration by engineers as well as by financiers.

In the electric power industry, "fixed charges" on the investment are usually figured at about 12½ per cent, varying according to conditions surrounding the enterprise from 11½ to about 15 per cent. Generally, interest is taken at 6 per cent, taxes and insurance at 1½ or 2 and the remainder averaging about 5 per cent per year is to cover the rather vague, indefinite or uncertain item of depreciation or amortization of the investment which is provided for the purpose of "writing off" the original investment during the effective life of the enterprise or before it becomes obsolete. Just what should be allowed for this item of obsolescence is a matter of much discussion and impossible of accurate analysis in advance because of the uncertainty of the technical and financial developments of the future. In fact, even after a set of equipment has been put out of service, it is rather difficult to figure just what the amortization allowance should have been.

From the figures obtained through recent investigations, I believe that 5 per cent of the original investment set aside each year during the useful life of the plant, would have amply covered the amortization of the older power stations in the Chicago District.

Just what should be allowed in the future for amortization, I shall not attempt to predict. But because of the present technical development of power stations, I believe that our new high pressure power stations will probably have as long or longer useful life than those which are now considered old type plants. There will certainly be further technical improvements in power stations but the technical advance will not be as rapid as in the last 10 yr. and in any analysis of power station costs for the future, the matter of fixed charges on the investment will have to be considered of paramount importance. In our methods of transmission and distribution of electric energy, I am inclined to think that developments of the mercury arc rectifier and the thyratron tube are likely to make some revolutionary changes

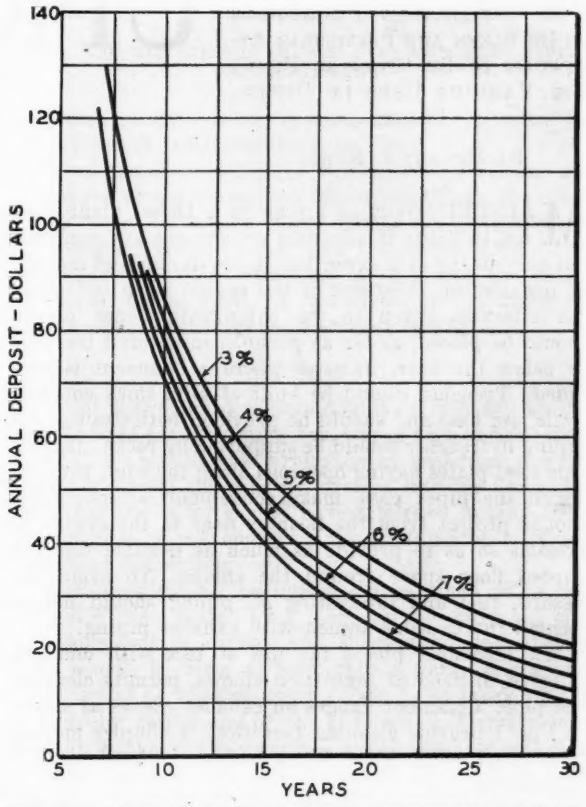


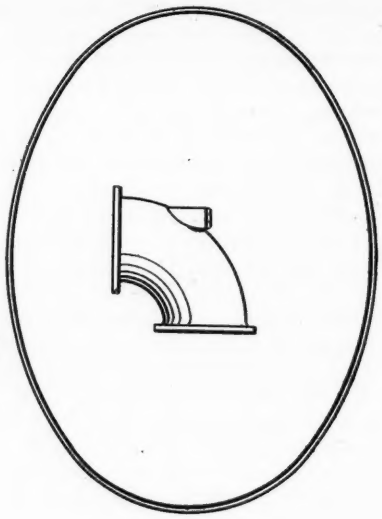
FIG. 2. AMORTIZATION DIAGRAM SHOWING ANNUAL DEPOSIT REQUIRED TO EQUAL $1000 WITH VARYING RATES OF INTEREST COMPOUNDED ANNUALLY

which will compel us to write off some of our present equipment in a comparatively few years.

Technical progress undoubtedly will continue, but probably it will not be quite as fast and furious as it was during the past 10 yr. It will be more carefully studied and thought out in advance, both from an engineering and an economic point of view. The matter of amortization of plant and equipment will be of increasing importance. Probably new investments in plant, especially in manufacturing industries will have to be written off in shorter time than has heretofore been considered necessary, due to the fact that the equipment is made obsolete in a few years by scientific and engineering developments and by changes in the products made necessary by the ever increasing progress in our modes of living.

COUPLINGS should be inspected regularly, taken up and lined up as may be necessary.

DIESEL ENGINE UPKEEP



PART XVIII, PIPING MAINTENANCE. PROPER MATERIALS TO BE USED, INSTALLATION PRECAUTIONS TO BE TAKEN AND PARTICULAR ATTENTION TO BE GIVEN TO PIPING FOR VARIOUS USES IN DIESEL PLANTS

BY EDWARD J. KUNZE

MAINTENANCE of piping in a Diesel plant need not be costly if adequate precautions are exercised not only in the care given but in the design and method of installation. Neatness of the engine room influences the attention given to the equipment, hence piping should be placed, as far as possible, in covered trenches or below the floor, in cases where a basement is provided. Trenches should be built of 4-in. thick concrete walls and base and should be provided with drains. All piping in trenches should be supported by racks. Removable steel plates having openings along the edge, through which the pipes pass, make convenient covers. Pipes should project from the floor as near to the engine as possible so as to provide as much as possible uninterrupted floor space around the engine. To avoid fire hazard, fuel and lubricating oil piping should not be located in the same trench with exhaust piping.

In accessible places the use of tees with one end plugged, instead of regulation elbows, permits cleaning the pipe. Clean-out flanges on exhaust elbows as shown in Fig. 1 provide cleaning facilities. A simpler method of accomplishing this is illustrated in the head piece of this article.

Accessibility is essential, hence provision should be made for breaking pipe lines at convenient places by the installation of unions or flanges. Pipe leaks are best taken care of by replacement. Circumstances do not always permit this to be done at once, however, hence temporary repairs may be required.

Leaks may be caused not only by the expansion and contraction set up by heat changes but by vibration, hence all piping extending from the engine to locations off the foundation should be provided with flexible joints to prevent transmission of vibrations.

Flake graphite and oil, preferably cylinder oil, is one of the best dopes for joints that may have to be dismantled. A mixture suitable for water pipes is composed of 10 lb. of thoroughly ground, yellow ochre, 4 lb. of ground litharge, 4 lb. of whiting and ½ lb. of finely cut hemp. This is mixed with linseed oil until it has the consistency of putty. For permanent joints, red lead may be used but for high pressures, a mixture of litharge and glycerine, mixed in small quantities for each joint, holds well but it sets quickly, so that a joint made with it cannot be changed.

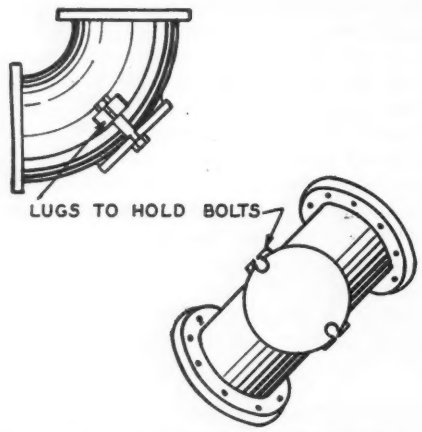


FIG. 1. EXHAUST ELBOW WITH CLEAN-OUT FLANGE

EXHAUST PIPING

Exhaust piping should be installed as direct and free from short turns as possible. The size of the line to the muffler should never be reduced below the size of the connection on the exhaust manifold on the engine. If a long exhaust line is unavoidable, the engine manufacturer should be consulted for the recommended exhaust pipe size. The regular line size should be increased if the total length of the exhaust pipe is over 30 ft. To prevent back pressure, bends should not be installed nearer than 6 ft. from the engine and short turn elbows

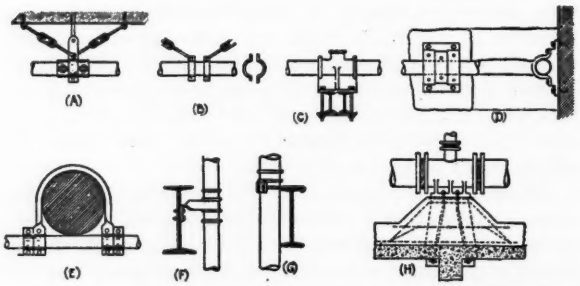


FIG. 2. PIPE ANCHOR TYPES. A AND B, SUSPENSION ANCHORS; C, ANCHOR TEE; D, WALL SUPPORT AND ANCHOR; E, COLUMN ANCHOR; F AND G, ANCHORS FOR VERTICAL PIPES; H, ANCHOR TO HORIZONTAL BEAM

should not be used anywhere in the line unless their size has been increased at least 2 in. over the regular size. An elbow in a pipe line adds as much resistance as a straight piece of pipe about 20 pipe diameters long.

Strain on the engine due to weight of exhaust pipe should be avoided. The ideal arrangement is a rigidly supported pipe line connected to the engine by a short piece of flexible pipe. The best arrangement for an air exhaust pipe rigidly connected to the engine is to run exhaust pipe directly outside of the building to the muffler, which rests upon rollers. Each engine should have its individual exhaust muffler or pit.

Fire Prevention

Where the exhaust pipe passes through a combustible wall or partition, it should be guarded by a galvanized iron ventilating collar, with no concealed space around the collar.

Fires have resulted from filling the space around an exhaust pipe with concrete, due to conduction of heat by concrete from the exhaust pipe to surrounding combustible material. When an exhaust pipe is less than 12 in. from a wall, a shield should be provided over the pipe to prevent combustible material from lodging between the pipe and the wall. All wood work or combustible material should be no nearer than two times the diameter of the exhaust pipe.

The exhaust line must be designed to allow for expansion resulting from a variation in temperature from that of the engine room to about 1000 deg. F. It should be anchored securely at some one point and allowance given for expansion. Anchoring methods are illustrated in Fig. 2.

Fuel Oil Piping

Fuel oil piping and connections should be made up tighter than is customary for water piping. Wrought iron, steel, brass or copper pipe may be used, preferably one of the latter two for lines between the fuel strainer and engine and between the day tank and engine. Some engineers recommend fiber and leather for gaskets but general preference is given to brass unions, without gaskets, preferably having ground joints. In case these pipes become clogged, they can best be cleaned by disconnecting and heating them to dull redness.

Fuel oil piping should be so located that, in case of leakage, oil cannot come in contact with hot exhaust piping. Use of tees, with one end plugged, instead of conventional elbows facilitates cleaning of the lines.

Readily accessible fuel strainers should be installed in fuel supply lines before valves or parts liable to become clogged, are reached. Shut-off valves in fuel lines should be secure against leaks and close against the supply. Openings for fuel pipes through outside walls below ground level should be made oil tight by filling the space around the pipe with neat concrete.

Lubricating oil piping and oil holes should be cleaned out at least once a year by blowing with compressed air, then washing with kerosene and finally blowing out again with air. Joints should be examined monthly.

Unless automatic arrangements have been provided, circulating water should come to the circulating-water header on the engine under a static head. Threads in all fittings should be clean and sharp, pipe ends fully threaded, dopes should be avoided and unions should have either ground joints or copper or cloth inserted rubber gaskets.

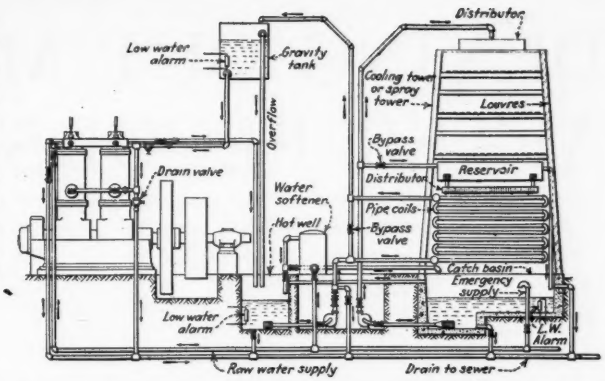


FIG. 3. DOUBLE CIRCUIT CLOSED SYSTEM WATER PIPING ARRANGEMENT

Combination cooling systems can be operated by proper piping arrangement as in Fig. 3.

Two distributors for the raw water are shown, one at the top of the tower for summer conditions, the other lower down, for winter duty. Sometimes, in extremely cold weather, cooling water from the engine is led direct to the tower basin. Provision for draining the entire system should be made. A two-circuit system which includes a heat exchanger is illustrated in Fig. 4.

Air Piping

Steel pipe of not less than double extra-heavy weight may be used for air piping but copper pipe is preferred. The fittings should be of ground-joint, gasketless design; not only should the pipe be screwed into the flange fittings but the latter should have setscrews locking them to the pipe. Some engineers use a Van-Stone, welded or brazed connection.

For cleaning, air piping should be taken off, a section at a time, heated by a blow torch to burn out any accumulations of carbon and thoroughly cleaned out. This should be done at least once a year. Air cooler coils should be cleaned every 12 mo. The inside of the L.P. cooler casing and of the H.P. and I.P. cooler coils may be cleaned by commercial metal cleaning material.

The inside of the L.P. coils and of the compound cooler casing should be washed out with water, then filled with a dilute solution of hydrochloric acid, 1 part acid to 10 water, to remove any accumulation of hard scale. This solution should be forced through the body of the cooler until effervescence ceases. After the acid has been used the cooler should be washed thoroughly, first with cold, then with hot water to remove acid.

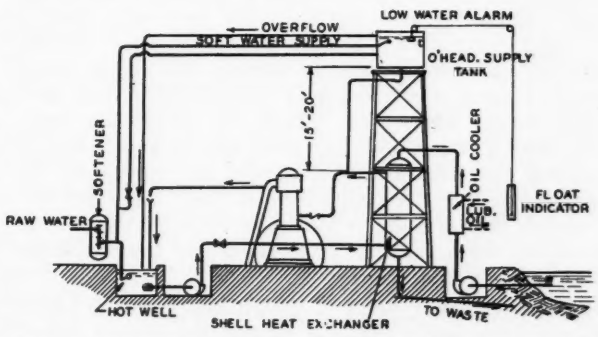
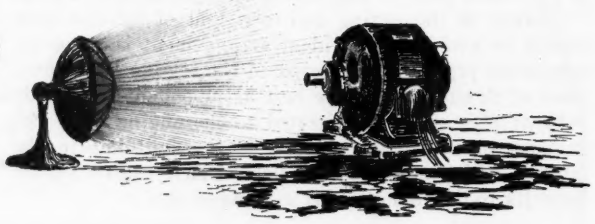


FIG. 4. DIAGRAM OF TWO CIRCUIT SYSTEM IN WHICH WASTE HEAT IS RECOVERED

DRYING OUT MOTORS AFTER FLOODS



By S. C. Smith
Industrial Engineering Dept.
General Electric Co.

MANY DIFFERENT METHODS have been used to recondition motors after flooding; the method employed usually being dependent on the tools and equipment available.

As an example, during 1929 at Harriman, Tenn., the Emery River rose approximately 40 ft. and flooded a temporary warehouse containing new motors and electrical equipment. The motors were completely submerged for a number of hours and when the flood was over quantities of mud and debris covered the equipment. To clean the motors, use was made of a fire hose, washing the disassembled parts of the motors with clean water. Steam heat was available so the parts were placed in a room with steam pipes around the walls and on the floor, and baked until dry.

In 1930 San Antonio, Texas, was unfortunate in having a number of synchronous motors submerged in water in its sewage disposal plant. The conditions at the plant were such that it was impossible to dry them out there so they were sent to a local repair shop for reconditioning. The motors were cleaned thoroughly with carbon tetra-chloride, after which the stators were dried in an electric oven and the fields dried by passing low direct current voltage through them. A Megger was used every few hours to measure the resistance of the insulation and after approximately 72 hr. the windings were completely dry. Visual inspection of the windings showed that insulating varnish was needed and a coating was sprayed on the surface of the windings.

Last year a large electric dredge sank in Lake Erie and all equipment was submerged for several days. After the dredge was raised to the surface, it was found that besides being damaged by water and sediment, the electrical equipment was damaged by the flooding of the crude oil tanks on the boat. In this case also the motors were sent to a local service shop to be cleaned and dried out. In addition to a thorough inspection and cleaning of mud and sediment, they were washed out and then placed in electric ovens to be dried. Before putting the motors back in service, the stators were either dipped or sprayed with oil-resisting varnish and then baked. There were several d.c. motors involved, too, and it was found that even after many hours of baking, the armatures still showed low resistance. It was found that the baking did not force the water out between the commutator clamping rings, so these were loosened, the armatures baked again and the resistance restored to a high value.

When a power plant of the Illinois Power & Light Co. at Jacksonville, Ill., was flooded, an entirely different method of drying the electrical equipment was employed. Tarpaulins were used to cover the machines to hold the heat which was supplied by a number of torches. Four-inch pipes with screens in the pipes, to prevent any sparks or soot from being forced through, were used to distribute the heat from the torches to the windings and laminations of the motors.

Cleaning Equipment After Submergence

Many such cases as this indicate the importance of taking apart and thoroughly cleaning electrical equipment after it has been submerged. Care should be used so that the windings are not harmed when applying water in a jet. Grease, oil and sticky dirt which cannot be taken off with water can be removed by the use of good cleaning liquids, such as carbon tetra-chloride, gasoline or naphtha. All of these liquids evaporate quickly and, if not applied too generously, will not soak or injure the insulation. Carbon tetra-chloride is best and is recommended because it is noninflammable. The other liquids, being inflammable, should be used outdoors or in a well ventilated room. The coils should not be dipped, but should be cleaned with a cloth saturated with the liquid. A paint brush can be used to advantage to get to corners and between small coils. All metal parts should be cleaned and painted to prevent corrosion and the bearings should be opened and drained. The bearings should be wiped clean and new oil put in.

Drying by Means of Current Through the Windings

The most effective method of drying out the motors is to pass current through the windings, using a voltage low enough to be safe for the winding even in its moist condition. For 2200-v. motors, 220 v. is usually satisfactory for circulating this drying-out current. Thermometers should be placed on the windings to see that they are being heated uniformly. Temperatures should not exceed 90 deg. C. (Class A insulation). If the temperature is raised too quickly or greatly exceeds 90 deg. C., gas is likely to puncture the insulation and ruin the winding. Applying the heat internally by passing current through the windings drives out all moisture and is particularly effective on high voltage motors where the insulation is comparatively thick.

Small d.c. or a.c. motors can more conveniently be baked dry in an oven, keeping the temperature of the oven not over 100 deg. C. for Class A insulation.

With larger machines, heat may be applied externally by placing heating units around or in the machine, covering the whole with canvas or other covering, and leaving a vent at the top to permit the escape of mois-

ture. In doing this, it is essential that there be a circulation of warm air over all the surface to be dried. The air should be allowed to escape as soon as it has absorbed moisture. Therefore, the heaters should be so placed and baffles so arranged as to get a natural draft; or small fans may be used to force circulation. Twelve inch fans set to blow air across the fronts of the heaters and then into the lower part of the machine from opposite ends, and so on up around the windings and out the top will produce excellent results.

Time Required for Drying

The time required for completing drying depends considerably on the size and voltage of the motors and the method used. While the motors are drying, the insulation resistance should be taken at intervals of 4 or 5 hr. These should be plotted as a curve, using time for the abscissa and resistance for the ordinate scale. Readings should be taken and the drying continued until approximately constant values are obtained. The value of resistance should at least equal the recommended standard—namely,

$$\text{Megohms} = \frac{\text{Voltage}}{\text{KVA} \times 1000}$$

The insulation resistance of dry motors in good condition is considerably higher than this value.

Perhaps, the most convenient way to measure this resistance is through the use of a Megger, although if a 500-v. d.c. source is available, readings can be taken with a voltmeter. The ungrounded side of the system should be connected to all the motor terminals through the voltmeter, the opposite or grounded side being connected directly to the motor frame. The insulation resistance is found by

$$R = r \left(\frac{V}{E} - 1 \right)$$

Where R = insulation resistance in ohms
E = line voltage (d.c.)
V = voltmeter reading
r = resistance of voltmeter.

In using the voltmeter method, the connection to the frame should always be made through a fuse of not more than 10 amp. in size. The circuit should be tested and the side showing a complete or partial ground then connected to the frame through the fuse.

For large machines, the insulation resistance readings should be taken as indicated above. As long as readings are consistent, the condition of the insulation would ordinarily be considered good. Low readings would indicate increased current leakage to ground, or to other conductors, owing to one of perhaps several causes, such as deteriorated insulation, moisture, dirty or corroded terminals, etc.

Obviously, the insulation resistance varies over a wide range, depending upon moisture, temperature, etc., but it is a good indication of the general condition of the insulation and its ability to stand the operating voltage. Such readings should be taken before a high potential test, to determine whether the insulation is ready for such a test and afterwards to make sure that the high potential has not injured the insulation.

Testing After Drying Out

After the windings have been dried out and repairs made, if found necessary, a high potential test should be given the windings to determine the dielectric strength of the insulation. New windings should successfully stand a high potential test of twice normal voltage plus 1000. There is some disagreement as to the proper value to use for motors that have been in operation for some time, but it is reasonable to assume that, after thorough cleaning and drying, the winding of a used motor should stand 150 per cent of normal voltage for 1 minute.

Small high potential testing sets are available for such work and are of such capacity that very little damage will result from a breakdown during the test.

If the motors can be spared from service long enough, it is highly desirable to dip and bake the stators or armatures and wound rotors of small motors in a good grade of insulating varnish. For larger machines, the varnish may be sprayed or brushed on. The metal parts afterwards should be cleaned by using a solvent of the varnish. For severe acid, alkali or moisture conditions, a black plastic baking varnish is best, while for conditions where oil or dust is present, a clear yellow varnish should be used.

After the varnish is applied, the best results are obtained by baking for 6 to 7 hr. at about 100 deg. C. Experience with particular conditions of operation or the condition of the insulation may indicate the desirability of applying several coats of varnish, each followed by baking periods at 100 deg. C.

When the motors cannot be spared from service long enough, or if facilities are not available for baking, fairly good results can be obtained by applying one of the quick drying black or clear varnishes which will dry in a few hours at ordinary room temperature.

Contractors at Black Canyon, according to reports of R. F. Walter, chief engineer of the Reclamation Service, to Secretary Wilbur, have "holed through" on the pioneer bore of the first of the great tunnels which are to carry the flow of the Colorado River while Hoover Dam is being built, thus establishing a mark of progress on the Government's biggest job since the Panama Canal.

In a single day recently, he reports further, the crews working at 11 different heads, drilled and excavated a total of 163 linear feet of tunnel.

As a matter of fact, the task of driving four tunnels, each 50 ft. across and each practically a mile long, one of the major undertakings of the whole enterprise, is in this way shown to be well under way and progressing rapidly. With but a year of work, most of it preliminary, Mr. Walter says, the contractors are today six months ahead of their schedule.

Central Illinois Public Service Co. has been authorized by the Illinois Commerce Commission to issue and sell $600,000 first mortgage gold bonds, dated June 1, 1931, maturing June 1, 1981, bearing 4½ per cent interest, to reimburse the company for expenditures made and to be made. The commission directed that the sale price be such that the company receives not less than 85 per cent of the net value. The Peoples Gas Light & Coke Co., Chicago, has been authorized to issue and sell $7,900,000 capital stock at not less than par.

Repulsion Starting *for* Capacitor Motors*

THE CHARACTERISTICS OF SINGLE-PHASE MOTORS ARE IMPROVED CONSIDERABLY BY THE ADDITION OF A CAPACITOR WINDING ON THE STATOR. HIGH TORQUE AND LOW CURRENT DURING STARTING ALSO CAN BE SECURED BY THE USE OF A REPULSION TYPE OF ROTOR.

By EDWARD BRETCH

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BECAUSE OF THE DEMAND for single-phase motors with better electrical characteristics and for reliable inexpensive capacitors, considerable interest has been exhibited in the use of the capacitor motor. The stator of this motor has a second single-phase winding connected in series with a condenser and energized from the supply line. With this form of single-phase motor, it is possible to approximate the efficiency and quietness of a polyphase motor, and at the same time to improve greatly the over-all power factor.

The problem of starting capacitor motors is about the same as in the case of single-phase induction motors without capacitor winding. Two general methods are available; the split-phase or rotary-field method of starting with a squirrel-cage rotor, and the commutator or repulsion method, in which the rotor currents are commutated for starting and are short-circuited at running speed to operate as a squirrel-cage motor.

In the capacitor motors so far developed, split-phase starting and a squirrel-cage rotor have been used. With this means it is possible to use the capacitor winding as the split-phase winding during starting. Where a fixed condenser and a squirrel-cage rotor provide efficient starting torque, and the starting currents are not objectionable, this split-phase method of starting is desirable; however, where the locked rotor and low-speed torque must be exceedingly high, and heavy starting currents are objectionable, the repulsion method of starting has a considerable advantage over the split-phase method. Accordingly, an investigation was made of the practicability of a repulsion-starting capacitor motor; that is, a motor starting by the repulsion method but having a capacitor phase-winding on the stator.

The stator of a 1/6-hp. standard repulsion-induction motor was rewound for capacitor operation; the repulsion rotor was used for starting and then when up to speed was short-circuited in exactly the same manner as with the standard repulsion-induction motor. As shown by the curves, this capacitor winding had the effect of increasing the efficiency, power factor and output of the motor. Due to the increased efficiency, the capacitor motor operated at the same temperature rise at ¼ hp. that it did as a 1/6-hp. plain repulsion-induction motor, corresponding to about a 50 per cent increase in output. Also, it tended to eliminate noise, combining the better running characteristics of the capacitor motor with the starting characteristics of the repulsion-induction motor. Repulsion starting provides the same starting characteristics for the capacitor motor that it does for the plain induction motor, giving high locked-rotor torque with low locked-rotor current.

Comparing a ¼-hp. repulsion-capacitor motor with a split-phase capacitor motor of the same rating, it was found that although the pull-out torque of the repulsion motor was less than that of the split-phase motor, and the full-load torques were the same, the locked-rotor torque of the repulsion motor was considerably greater. Also, the locked-rotor current and energy of the repulsion motor were reduced by more than half, and the full-load efficiency and power factor were increased.

Another advantage of the repulsion-capacitor motor is that a 7.5-mf. condenser could be used in series with the capacitor winding for both starting and running, while the split-phase capacitor motor required a 7.5-mf. condenser for running, and a 45-mf. condenser for starting. In the event of condenser failure, the repulsion-starting capacitor motor can still be operated as a plain repulsion-induction motor. Further, the equipment is fundamentally more substantial and reliable, as no over-voltage or surge is imposed upon the condenser at starting.

Considering both squirrel-cage and repulsion motors, together with their condensers and accessories, there is some question as to which will be the more costly. In the repulsion-capacitor motor, the extra cost of the capacitor winding is not so great as in the squirrel-cage capacitor motor, as in the former the condenser is of small size and can be connected permanently in the circuit, eliminating any automatic cutout or the switches required for starting with the split-phase method. Although the addition of a capacitor winding increases the cost of a motor, the fact that a smaller motor may be used for a given output will in part, at least, overcome this extra cost.

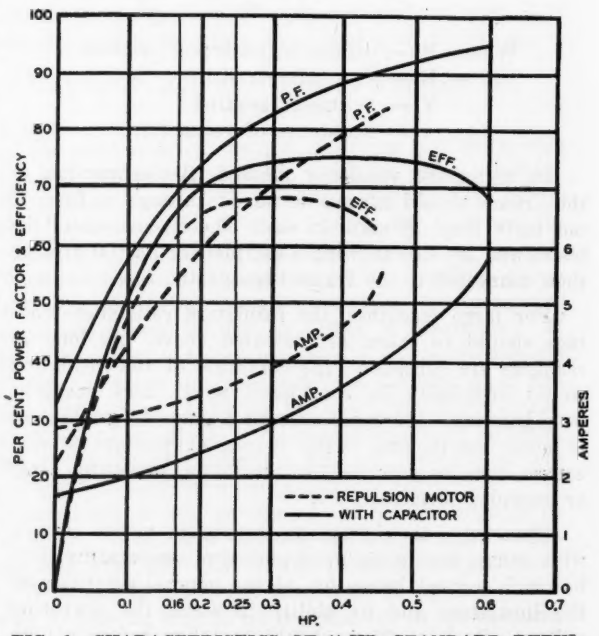


FIG. 1. CHARACTERISTICS OF 1/6-HP. STANDARD REPULSION MOTOR, AND AS REWOUND FOR A ¼-HP. REPULSION CAPACITOR MOTOR

*Abstracted from an article in Electrical Engineering published by the American Institute of Electrical Engineers.

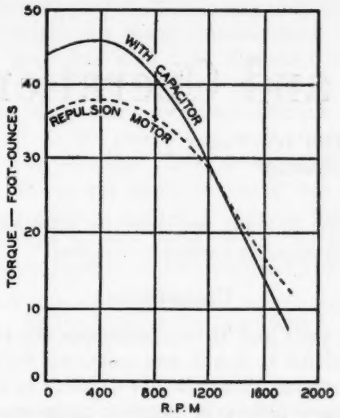


FIG. 2. SPEED TORQUE CURVE OF STANDARD REPULSION MOTOR AND WITH A CONDENSER CONNECTED PERMANENTLY IN THE CAPACITOR PHASE

On applications where the starting conditions on single-phase motors are severe, the repulsion-capacitor motor has a decided advantage over the other types and should be practicable on all sizes of motors, from the smallest to the largest.

Fuse Maintenance

By Marin Phillips

FUSES ARE to electrical circuits what safety valves are to steam boilers. They are, therefore, the maintenance man's best safeguard against personal injury and property damage. Despite this fact, fuses in a great many cases receive less of their share of regular maintenance than other pieces of plant equipment. This fact is supported by what one generally observes when considering the fuses about the plant. That they have been a source of annoyance, and considerable expense, is reflected in the junk box. Here we find charred and burned cases, numerous ferrules and contacts. This condition has brought about the inclination to eliminate fuses altogether from the circuit, disregarding the many profitable advantages offered by them.

Certain types of renewal fuses have come in for more than their share of trouble. This because they lend themselves readily to misuse and abuse. It is, for instance, a simple matter to increase their rating by refilling the cartridge with more than the required number of links. Numerous advantages are taken of this handy way to eliminate fuse blowing, with the result that more serious fuse troubles are created. In an emergency, such as changing to a larger motor, it is an advantage to be able to increase the rating of the fuse until the line switch or fuse block can be conveniently changed to accommodate the proper size fuse.

The writer had experience with one plant which paid very little attention to the rating of its line switches and fuse blocks. Instead, it adapted the fuses to the clips. This often meant doubling up on the links to as much as four times the rating of the fuse cartridge and contacts. This plant had an enormous fuse bill and numerous avoidable delays. In addition to this, nobody knew the rating of a fuse without taking it apart and inspecting the fuse link.

Renewal fuses are good for many years of continuous service at very low cost when properly maintained. The renewal cost of a fuse is practically negligible. It is when the cartridge and contacts are destroyed through prolonged heating that the cost begins to be noticeable. This destructive heating and premature blowing of the fuse can be practically eliminated by exercising a little care when refilling the fuse. When refilling the fuse all inside contact surfaces should be thoroughly cleaned with fine sand paper before inserting the fuse link.

The next important point relating to the satisfactory operation of the fuse is the condition of the fuse contact ferrules and blades. A fuse should never be placed in a fuse clip unless the contact surfaces of both are well cleaned. The fuse clips when clean and in good condition have sufficient contact pressure to carry properly their rated load. Where poor contact is maintained between the fuse clip and fuse the contact pressure will be destroyed by the heating of the contact.

Proper care of the fuse clips is a vital necessity in the satisfactory operation of the fuse. When a fuse clip has been once overheated, it is useless to keep on using it as it will keep on heating and destroying the fuses as long as it is in service. The only remedy is to replace the clip with a new one. A careful watch should be kept on the fuse clips when inserting fuses to see that the proper contact is maintained. A fuse clip that has never been overheated can be bent and shaped to make proper contact with the fuse when necessary.

Where fuses remain in the clip for a long time they are bound to corrode, thereby resulting in overheating. It is for this reason that the fuses should be pulled from time to time and all contacts thoroughly cleaned, whether they are giving any trouble or not. A good rule to follow which will assist in keeping the fuses in good condition is to turn the ferrule type around in the clips several times, pull and replace the knife contact type several times, every time the compensator or control equipment is inspected. Where fuses are in operation in locations where corrosive fumes are present, they will require frequent attention and cleaning. In some cases, it will be an advantage to keep the fuse contacts slightly coated with a corrosive prevention paste.

In general, two types of compression are spoken of, isothermal and adiabatic. Isothermal means compression at constant temperature, that is, if air at 60 deg. were compressed in a cylinder the temperature would be maintained at 60 deg. F. throughout the process. Inasmuch as the energy, outside of friction, that goes into compression goes into the air and tends to heat it up, this energy or heat would have to be abstracted as fast as as it is absorbed in order to keep the temperature from increasing.

Adiabatic compression means compression without adding or subtracting any heat from an external source. this energy or heat would have to be abstracted as fast as the temperature is raised. This increase in temperature increases the volume of the gas, or in the case of a compressor cylinder of limited volume increases the pressure, so that adiabatic compression takes more power than isothermal.

Because of the speed of compression in an actual cylinder, isothermal compression is impossible, because the heat cannot be taken away fast enough. Compression must, therefore, be almost adiabatic even in jacketed cylinders.

Modern Ice Plant Design and Operation

A Survey of Up-to-Date Practice in the Ice Plant

by R. T. Brizzolara* and E. C. Soares*

ICE PLANT design today tends toward simplicity, elimination of operations and lessening of arduous labors. There has been a general adoption of concrete, brick, steel and mill type flat roofs; engine rooms are adjacent to and on the same level as the tank floor. When possible, ice storage is ahead of the tank floor and on the same level. They are usually built on cheap land so that one-story construction can be used to eliminate handling problems and give the operator a full view of the entire plant. Buildings of this type cost, in New England, from $300 per t. for a 230-t. plant to $550 per t. for a 70-t. plant.

Ice storages for 60 to 130-t. plants, for day storage only, are built uniformly from 800 to 1400-t. storage capacity when used and have means provided for stacking, four to seven tiers high. Selection of the proper size storage depends upon the records of a Saturday's business in mid-summer, general requirements being that every storage must be such that no ice stacking is necessary for the plant's maximum harvest from Saturday noon to Monday morning. This rule has worked out well and has eliminated the necessity of season storage investments, undue stacking and handling labor.

Storages are insulated with sheet cork envelope laid in asphaltum, up the walls and over the roof. The floors are insulated with 36 to 42 in. of well-tamped soft coal cinders over which an oak floor is laid with ¼-in. spacing. When lower first costs are desired, the same floors are adopted and 12 in. of mill shavings used for wall insulation, with a 24-in. depth over the ceiling and over the roof. From 24 to 25 lb. back pressure is carried on the storage cooling coils and it has been found that 4 to 6 t. of refrigeration carry them satisfactorily at 28 deg. F. under New England summer conditions.

Brine Coolers

Brine velocity in brine cooler tubes is held to about 2 ft. per sec. as the agitator horsepower goes up rapidly at higher velocities. The heat transfer coefficient is found to be about 80 B.t.u. per sq. ft. per hr. per deg. F. With the trunk system, the heat transfer coefficient is found to range from 90 to as high as 120 B.t.u. per sq. ft. per hr. per deg. F. with velocities of from 2½ to 2¾ ft. per sec. Both types of coolers can be surfaced to obtain 3 or 4 deg. F. difference in temperature between the brine and ammonia.

Brine temperatures throughout the tank can be limited to 0.5 deg. F. maximum variation, with brine levels in a tank kept within a maximum variation in level of 1.5 in. Eighteen to 30 ft. per min. velocity between the cans has been found to give good results; 18 ft. used for wide spacing and 30 ft. for narrow spacing. Tanks should be so proportioned that lifting a full row will not drop the brine level more than an inch. Over a period of 3 yr., core pumping sets have been increased so that a row of cans can now be pumped in 6 min. instead of 25 min. as formerly required.

Condensers

Vertical shell and tube condensers are proportioned on a basis of 3.5 to 4 gal. per tube and with condenser surfaced to about 13 sq. ft. per t. there is about 1 deg. F. temperature difference between ammonia liquid and out water temperature. In installing ammonia piping the writers have been using 3500 ft. per min. suction line velocities and 2500 ft. per min. discharge lines, but consider that both these velocities are too high and result in material losses.

Freezing tank insulation is now made of 5 in. of sheet cork and 1 ft. of cinders beneath the freezing tank with 12 to 18 in. of regranulated cork on the sides. This is one of the items that permits basing freezing tank calculations on 1.54 t. of refrigeration per ton of ice, using 70 deg. F. water on one end and 11 deg. F. brine on the other.

Five to 6 deg. F. have been gained in the cooling of initial can water by submerging coils in water coming from the can spill when dumping ice. This can water of 36 deg. F. is augmented with the snow obtained from scoring machines and floor sweepings. The snow simply chutes from the storage to the cooling and melting pit in front of the dump. The entire cost of the latter arrangement is less than $500 for a 130-t. plant.

Condensers and Compressors

Condensing water is obtained from spray ponds operating within a 5 deg. F. temperature range and within 5 deg. F. of the wet bulb. Spray ponds should never cost more than $1.50 per gal., including installation and other expenses. Water is not carried on the roofs under spray ponds but immediately drained to the condensers and passes to the pumps under a slight static head.

Vertical single acting compressors in sizes up to 10 by 10 in. yield the greatest tonnage capacity per dollar. One can get 45 t. of ice making capacity today from a machine costing less than $2000. The poppet type valves have clearances of less than 1½ per cent while in the vertical plate type machine clearances run 5 per cent and even more which is a serious handicap during short periods in the summer when the humidity is high and no breeze occurs. Compressors of the type mentioned are no longer even set on foundations but both the 2 or 4 cylinder type are simply bolted to the floor. Except in rare cases there is no need for starting compensators on either large synchronous motors or auxiliary motor equipment as all apparatus can be started better by throwing them directly across the line. All safety equipment should be automatic.

Cranes, ice stacking machines, ice scoring machines and similar equipment should be operated at as low a voltage as practicable, and for the safety of the operator,

*R. B. Engineering Corp., New York, N. Y. Abstract of a paper presented before the New York Section of the A. S. R. E.

all portable equipment should have safety grounding type receptacles. In many installations, synchronous motors are provided with field rheostats which are an unnecessary contrivance. Synchronous motors, which will operate on a common direct current voltage, can be purchased at no increase in cost, thus saving the cost of the field rheostat (from $40 to $100) and at an average of $25 power costs per year per machine.

There is a gradual tendency towards the elimination of a switchboard as it is known today by concentrating the control, preferably at the engineer's desk.

AVERAGE OPERATING COSTS IN CENTS PER TON FOR 70, 130 AND 230 T. ICE PLANTS

Power	53.6 cents
Labor	26.0 cents
Maintenance	3.3 cents
Supplies	3.5 cents
Water (Unit cost high in N. E.)	8.2 cents
Total	96.5 cents
Plant Load Factor	60 per cent

Plants of the type described cost in the 65 t. sizes about $1500 per t. complete, exclusive of land. The average summer kilowatt consumption will range from 48 to 49 kw. per t. Plants from 80 to 130 t. capacity cost from $1400 to $1150 per kw. and require from 46 to 47.5 kw. per t. power consumption. The most economical plant sizes are found to be 80, 160 and 240 t. capacity. The average division of operating costs in cents per ton for year around operation averaging three plants of 70, 130 and 230 t. capacity would show up about as in the table.

New Pipe Line Interconnects District Heating Plants

Two Plants in Seattle Joined by 2000-Ft., 12-In. Welded Line

TWO DISTRICT STEAM PLANTS of the Puget Sound Power & Light Co. in Seattle have recently been connected so that the combined volume of 510,000 lb. of steam an hour is made available to either north or south districts of the city. The pipe line is 2000 ft. long, took 60 workmen two months to build and cost $50,000.

This tie-line unites the Western Avenue and Post Street steam stations of the company. It is a 12-in. full weight seamless steel pipe welded in place at the joints. Expansion joints every 300 ft. allow for a 6-in. movement; they are fastened by flanged joints.

In the trench was placed a 6 by 24-in. concrete slab and below the slab on both sides are 4-in. drain tile. On this slab rests a 2¾-in. concrete conduit with a 21-in. interior diameter. The conduit sections were placed in halves and cemented. Inside the conduit the pipe, with a wrapping of 2-in. sponge felt insulation, is surrounded with a 2-in. air space. Rollers at 9-ft. intervals take the movement of the pipe due to expansion and contraction, which amounts to 6 in. in 300 ft.

The felt insulation is in three-foot lengths. Joints are staggered and sealed by cementing heavy water proof paper over them.

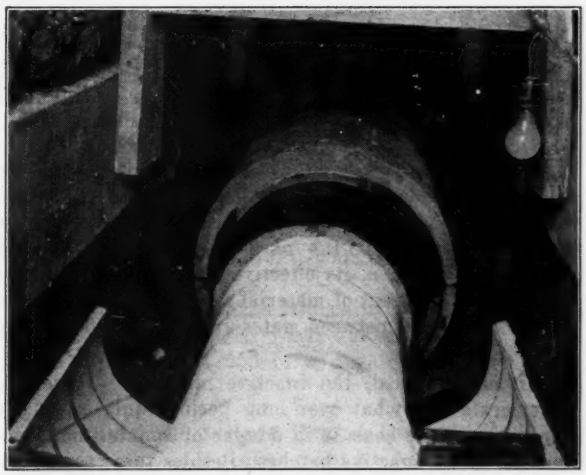


FIG. 1. STEAM LINE IN PLACE, SHOWING CONDUIT AND COVERING

Thus the two district heating plants of the company are made one, after having operated without connection for nearly 30 yr. A guarantee of uninterrupted service to the business and industrial districts is thereby made possible, declares A. L. Pollard, supt. of the steam division of the company. If failure should occur with one plant, the other is available and if demand increases more rapidly in one section than another, the increase can be taken care of by the combined plants, he pointed out.

Seattle is the ninth city of the country in the amount of steam sold by district plants. In 1929 the total was 828,280,000 lb. For 1930 a substantial increase is expected, and there is forecast for 1931 a gain of about 30,000,000 lb.

In addition to low-pressure steam for space heating the company also furnishes high-pressure steam to industrial plants. The low-pressure steam is delivered at 5 lb. and 228 deg. F., while high pressure is at 100 lb. and 338 deg. F.

Use of district steam for water heating in summer is becoming a worthwhile load factor. During July and August of 1930, more than 22,000,000 lb. of steam a month were sold for this purpose.

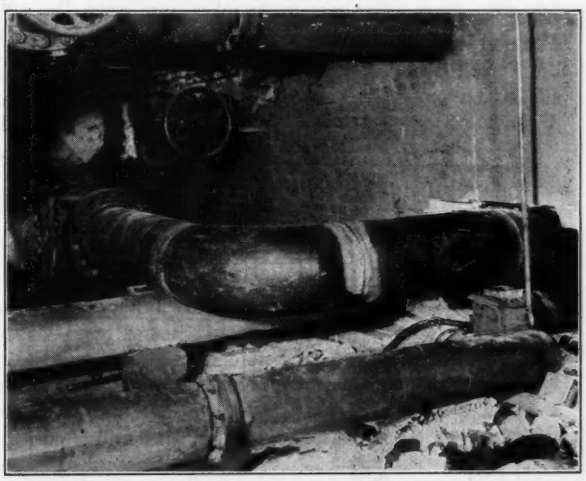


FIG. 2. MANNER OF WELDING JOINTS AND USE OF TUBE TURNS

Discharge Effectiveness of Bunkers

By Eugene Hahn

PERCENTAGE OF stored material that will be discharged from a bunker by flow from the gates without trimming or agitation is the index of discharge effectiveness. If a 100-t. bunker will discharge 75 t. with all gates wide open, its effectiveness is 75 per cent, as the other 25 per cent of material must be dislodged from corners or from between gates in order to flow from the bunker.

In case of coal, the inactive material is likely to deteriorate somewhat over long periods and, especially for high-volatile coals is in danger of spontaneous combustion in the inactive patches. Besides these considerations, it is illogical to pay for inactive storage space, hence full consideration should be given to providing as full effectiveness as possible in bunkers.

Requirements for design to get effective discharge have been found as follows:

Avoidance of angles of 90 deg. or less as such angles will retain coal, especially bituminous, lumps as well as fines.

Avoidance of horizontal or near surfaces in the bottom of the bunker between adjoining gates. Slope should be at least 30 deg. where pressures set up favor resting of coal on the sloping sides, Fig. 1. These component pressures vary with the loading of the bunker, vertical components being greatest when fully loaded and lateral pressure being less as one part of the bunker is emptied. These variations upset assumptions as to angle of repose of the material in a fully loaded bunker, particularly for bituminous coal with its high coefficient of friction. They are also productive of arching over the outlets of gates. The tendency to arch over is greater, the steeper the slope towards the gates, hence the difficulty of designing a bunker which will have 100 per cent effectiveness of discharge under all conditions.

To overcome arching, a mechanical agitator, Fig. 2, placed within the bunker but operated from outside seems the effective solution, the arms extending sufficiently above the gate opening to break up any arch that may form. For wet material, where even the agitator may be insufficient, access doors, Fig. 1, which permit dislodging material without entering the bunker,

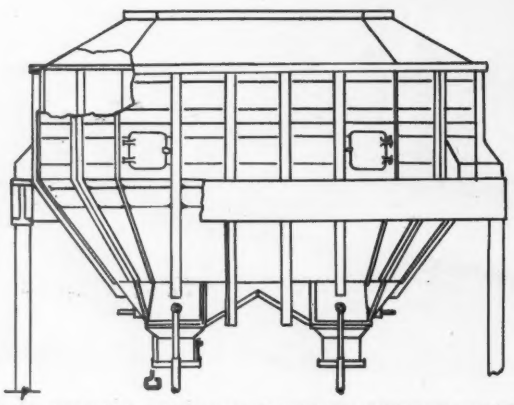


FIG. 1. BUNKER HAS ALL OBTUSE ANGLES, SLOPING FLOOR, ACCESS DOORS AND STEAM PORTS.

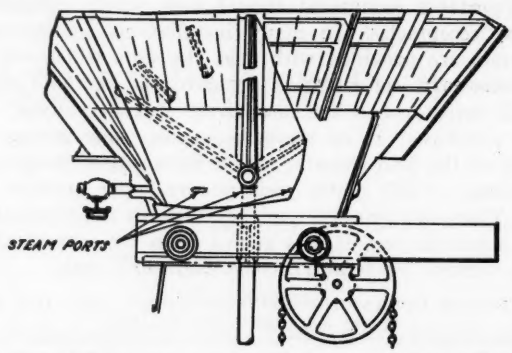


FIG. 2. HORIZONTAL SHAFT WITH CUTTING ARMS AND OUTSIDE HANDLE TO BREAK UP ARCHING. STEAM CHAMBER AND PORTS IN HOPPER BOTTOM.

avoid the danger of avalanching of material upon a trimmer when working inside the bunker. It is desirable to avoid entering the bunker and access doors can be so placed as to accomplish this.

One factor in arching and in ineffective discharge is the condition of interior surfaces. These must be kept in condition to avoid corrosion, usually accomplished for steel plates by coating with a bitumastic solution which should be done only when the bunker is emptied. Where non-machined, cast-iron plates or a lining of cement is used, no coating is required as the surface itself is noncorrodible.

When wet material is to be handled in freezing weather, some means must be provided for thawing. Steam coils inside the bunker form an obstruction to flow of material. Conduction through the walls from outside steam coils is inefficient. Horizontal slots for injecting live steam through the wall, Fig. 2, so arranged that an overhang prevents clogging with material have been found effective and may well be located just above the gates.

Methods of Determining Sulphur in Gasoline Studied By Bureau of Mines

As virtually all specifications for gasoline limit the amount of sulphur allowed in the fuel, it is highly important to have an accurate method for obtaining reproducible results in determinations of the sulphur content of gasoline, says the United States Bureau of Mines, Department of Commerce, following an extensive study of the problem. The lamp method proposed by Graham Edgar and George Calingaert, combines several features which make it the most desirable of the methods that so far have been proposed for the routine determination of the total sulphur content of gasoline, the Bureau states in Technical Paper 513, by Ralph H. Espach and O. C. Blade, just published. A special highly sensitive indicator is suggested by Espach and Blade as a modification of the original Edgar and Calingaert method.

Elemental sulphur can be determined up to 0.1 per cent; sulphides and disulphides up to 0.3 per cent.

Additional information in regard to the results of this investigation are given in Bureau of Mines Technical Paper 513, "Studies on Determination of Sulphur in Gasoline," which can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of five cents.

Ice Prevention at Racks of Hydraulic Plants

DESCRIPTION OF TWO INSTALLATIONS OF ELECTRICALLY HEATED RACKS, ALSO OF OPEN-CHANNEL AND OTHER MECHANICAL METHODS

TWO INTERESTING installations of electrically heated racks at hydroelectric plants as reported in the latest report of the Hydraulic Power Committee, N.E.L.A., are described below.

In the Shawinigan Falls Plant of the Shawinigan Water and Power Co., three units rated 43,000 hp. at 143 ft. head required a total of 400 kw. each to heat the racks. This is equivalent to 121 w. per c.f.s. of water consumed by the wheel; in other words, the amount of heat added to the water is sufficient to raise the temperature of the water approximately 1/540 of one deg. Complete details of this installation are given in the April, 1928, issue of the Journal of Engineering Institute of Canada. The only change in the installation due to another year's experience had been to reduce the power consumed to the above 121 w. per c.f.s. which is about half the former value.

Energy of water falling 778 ft., if completely expended in heating the water, would raise its temperature 1 deg. F., therefore a fall of 1 ft. is equivalent to warming the water 1/778 deg. F. In the foregoing example, the energy was sufficient to raise the temperature of the water 1/450 deg. F. which would be equivalent to a loss of head of 778/540 or 1.4 ft. This would be almost exactly equal to 1 per cent of the total head. From this point of view, energy required for heating racks may be directly translated to terms of head and it will be seen that this form of protection is much more interesting for high-head plants than for low-head plants.

At the Aberfeldie Plant of the East Kootenay Power Co. on the Bull River in British Columbia, it had been impossible, since first placing the plant in operation in 1922, to utilize more than approximately 25 per cent of the available water during the months of December, January and February, on account of the quantity of frazil ice which was carried with the water.

Following along the lines of the experiments conducted at Shawinigan Falls, an installation of electrically heated racks was made. The intake racks are approximately 17 ft. wide and 17 ft. deep, consisting of ¼ by 2½-in. bars on 2-in. centers.

The racks utilize about 100 kw. of electrical energy and with the degree of heat so developed the racks keep entirely free from ice during the most extreme conditions. Slush and frazil ice do not collect in the area in front of the racks or on the racks themselves but pass freely through the racks and have apparently been heated sufficiently so that they have no tendency to stick on the guide vanes or runners of the wheels. The plant has operated during the last two winters with little additional attention.

Based on a water consumption of 150 c.f.s., the addition of 100 kw. is equivalent to raising the temperature approximately 1/100 of a deg. F. The head at this plant is 290 ft. so that this 1/100 deg. is equivalent to a loss of 7.78 ft. or 2.7 per cent in head. The initial cost of the electrically heated racks installation was more than paid for by increased kilowatt-hour output during the first month of operation.

The Cohoes Plant on the Hudson River also uses 300 kw. in electrically heated racks for units using 2500 c.f.s., equivalent to 1/550 of a deg. F. rise in water temperature.

MECHANICAL RACK RAKING DEVICES

The only installation where a mechanical rack raking device has been reported as used for combating ice is on the Hull No. 1 and Hull No. 2 plants of the Gatineau Power Co., on the Ottawa River, at Hull, Quebec. These plants have exceptionally difficult operating conditions since there is approximately one mile of open rapids terminating about 1000 ft. above the power house.

The raking device consists of a larger number of gear wheels which are rolled up and down the sloping rack bars by a motor operated mechanism. This does not bring the ice to the surface for disposal, but actually breaks the ice up and pushes it through the racks. The tops of the racks are exposed to the air and are not heated in any manner. Before installing these devices it was impossible to keep the racks clear with several men per turbine, but since the installation full load can be carried on these plants almost continually.

Several commercial rack raking devices on the market have proved successful for removing leaves, twigs, bark and sewerage material but evidently they have not been used to any extent where severe frazil and shell ice is encountered.

AIR BUBBLERS FOR RAKING RACKS

Two operating companies, the Alabama Power Co. and the Shawinigan Water & Power Co., report success with air bubblers releasing the air at the foot of the racks. For trash and leaves, this is effective if the water velocities are low, or if the load can be partly removed from the turbine. The Shawinigan Co. reports some success with bubblers for helping to loosen ice from racks, attributing the benefit more to the effect of the warm water carried up from below by the air than to the lifting effect of the rising air.

OPEN CHANNELS FOR BYPASSING ICE

On some relatively low head plants of from 20 to 50 ft. head, the quantity of water used is so great that it is practically impossible to supply enough heat to the racks to raise the temperature high enough to prevent trouble from frazil and slush ice.

On several of these plants, it has been found advisable to waste as much as 10 to 15 per cent of the total water available in the river in order to flush away a large percentage of the frazil and slush ice contained in the entire stream.

After an ice cover of 2 or 3 in. has formed in the early winter, one or two channels are cut diagonally

across the pond from the end of the dam away from the intake to a point on the shore upstream from, but on the same side as the intake. A small spillway is opened in the dam at the end of this open channel and all the ice is towed down and sluiced over this opening with the wasted water.

With this system, the water flowing down the river toward the intake must pass underneath the open channel. The slush and frazil ice, being somewhat lighter, float to the top and a large percentage of them is caught in the open channel along which they are dragged, either by hand or by teams and drags and sluiced over the dam. In some of the streams containing a large percentage of slush ice, it is sometimes necessary to cut as many as three or four channels parallel to the first channel, also diagonal to the direction of flow of the water. Such channels require a great deal of labor and time to keep open and clear but at many of the northern plants this method has been the only one by which the plants can be kept in operation during the cold months.

Where there is no cake ice or floating surface ice which might damage parts of the waterwheel, many of the more recent plants equipped with propeller runners are able to remove their racks and pass the soft frazil ice through the runner without any appreciable plugging up. In the older plants equipped with small single runner vertical Francis turbines, or twin or four runner horizontal Francis units, frazil ice will block the runners completely in from 15 min. to 1 hr., depending on the amount of frazil ice present.

At the Cedars Plant of the Montreal Light, Heat & Power Co., with the 11,000-hp. Francis type runners at 30 ft. head and 56 r.p.m., there is so much floating surface ice together with masses of frazil from the rapids of the St. Lawrence River, that the 16-ft. diameter runner, as well as the spiral casing, is sometimes plugged with ice. An open channel is maintained by two steel tug boats, the ice being kept moving down toward an overflow sluice where it is discharged into the tailrace. The use of tugs and some booms across the intake to direct part of the floating ice away from the intake has reduced the cost of ice fighting at this 180,000-hp. plant until it amounts to hardly more than that spent on a 20,000-hp. plant of about the same head where the ice must be handled manually and with teams.

First No Fuse Town

Ridgeville, South Carolina, has the distinction of being the first town in which the distribution of electric current to domestic users does not involve the use of fuses in the household wiring circuits, which are protected, instead, by small circuit breakers.

This unusual distribution system is a result of the South Carolina Power Co.'s efforts to build a larger rural load without incurring a correspondingly larger, or possibly even a proportionately greater, increase in the cost of operation. Two years ago, to prevent a wide growth in isolated rural areas of a type of house wiring that would be a source of continual demand on the power company for assistance in replacing blown fuses, the company instituted a regulation providing that in all towns of less than 1000 inhabitants domestic breakers, instead of fuses, be installed in all new house wiring and in all alterations or additions to existing circuits.

Ridgeville is the shopping center of a small but prosperous rural section. The number of consumers within the limits of the town averages only 250, but the electric service in the community includes lumber mills, brickyards, gins and grist mills.

Conforming with the power company's usual practice, outdoor meters are installed throughout the entire community. They are used with the usual connection box, and the regulation established by the company requires that the line from the meter be brought into the house by means of the shortest possible connection to an approved and accepted form of service breaker or load center instead of fuse. In the homes, these breakers and load centers are installed at various convenient positions where in case of an open circuit the service can be re-established without difficulty by a member of the household. It requires simply a movement of the breaker handle which is done as easily as the opening or closing of any type of toggle switch handle. There is no part to replace and no live parts are exposed. Unless several attempts to reëstablish the service are without success, evidence of serious difficulty in the circuit, there is never occasion to call on the power company for assistance.

Second International Heating and Ventilating Exposition, Jan. 25, 1932

It is now possible to give prospective visitors some idea of the interesting things they will see at the Second International Heating and Ventilating Exposition, to be held in Cleveland, Ohio, January 25th-29th, 1932, under the auspices of the American Society of Heating and Ventilating Engineers.

Interest will center in the changes which have been made in standard equipment since the 1930 Show in Philadelphia.

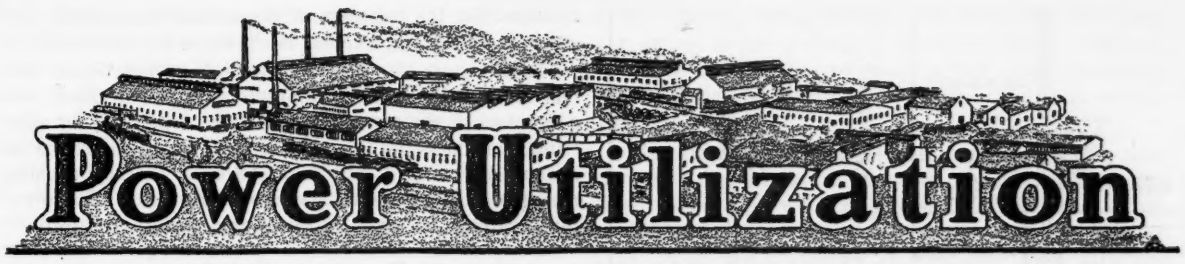
Perhaps in no section will the evolution be more marked than in the oil burner, gas heating and domestic stoker exhibits.

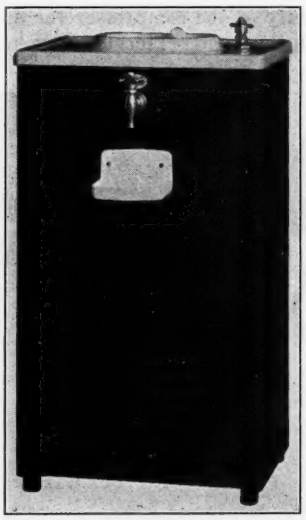
Unit heaters and non-ferrous metal radiation will be in the limelight in the warm air heating section, which will also contain interesting displays of fan-circulation warm-air furnaces. Air conditioning displays will reflect up-to-the-minute progress in this important field.

How rapidly the warm-air furnace heating industry has advanced in the way of providing positive controlled circulation of the heated air will be seen in the displays of automatic furnace fans. These include both the propeller and centrifugal types, as well as housed-in blowers both with and without bypass louvers.

Further refinements in this connection take the form of furnace air filters to insure a clean air supply, and automatic controls of both fan and louvers.

Emphasis will be laid by one manufacturer of a circulating unit for hot water heating systems, domestic hot water recirculating system, ice water circulating and similar systems on a trend which has developed during the past three years involving a fundamentally new conception of radiator heating. In this new conception hot water is used as the carrier of the heat units, the movement of that carrier being entirely independent of its temperature. By this method, it is claimed, it is possible to secure a greater heat transfer efficiency from the flue gas to the water and thence to the radiator surface. Notable advances will be seen in the design of radiator covers.

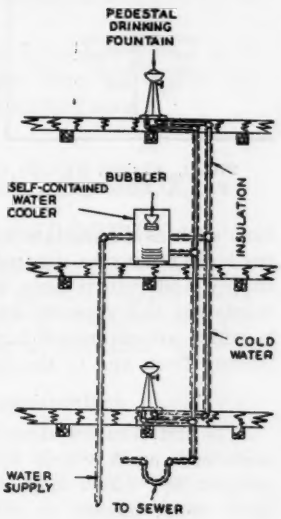




Water Cooling *for* Industrial Plants

Multiple Cooler Coils, Individual Coolers, Cooler Capacity

By L. M. JORDAN



PRINCIPLES and general details of the circulating system for cooling drinking water on a large scale were presented in the July 1, 1930, issue of Power Plant Engineering by the writer. This system is the most economical where large groups of persons are to be served over a limited area and where none of the fountains are more than 2500 ft. from the cooling plant. Any number of circuits may be operated from a single central compressor, hence this method is adaptable to any establishment whose dimensions do not exceed 5000 ft. in any direction and, as the capacity of this system is practically unlimited, it is often best suited to industrial plants where the requirements are heavy. But for lighter usage the multiple or individual systems may be better suited.

Multiple Coolers

While the multiple system is highly efficient, with condensing capacities at present available for use with this method, distribution areas to which it is adapted are limited. The greater efficiency of this system as compared with the circulating system results from diminished transmission line losses. It is made up of a central cooling plant, as in the case of the circulating system, which supplies a number of fountains. Cooling takes effect, however, at the point of consumption, each fountain being equipped with an individual expansion coil housed in a stand or support, some taking the cabinet form while others are simple cylindrical chambers, which may be supported by floor stands as indicated in Fig. 1, mounted to walls or columns as shown in Figs. 2 and 3 or suspended to the ceiling, either open or built in. Liquid refrigerant is transferred to the coils by condenser pressure through suitable piping and the expanded gas returns to the compressor through a separate return line. The number of coolers that may be operated on a single hook up in a multiple system depends upon the capacity of the compressor and the height to which the gas lines must extend, which latter factor is governed by the condenser pressure and the friction of the liquid lines. The horizontal length of the gas lines is limited only by the friction of the lines as no lift is required.

Pressure and Lift

With an air-cooled condenser the lift head possible will be greater than with a water-cooled condenser, hence the liquid lines can extend to greater height as in a multiple story building. Assuming a condenser pressure of 80 lb. and a frictional loss of 25 per cent or 20 lb., the effective lift head would be 60 lb. As the specific gravity of liquid SO_2 is 1.45 and one pound pressure will lift a column of water 2.37 ft., one pound pressure will lift SO_2, $2.37 \div 1.45 = 1.63$ ft. Then the effective lift head of 60 lb. pressure would be $60 \times 1.63 = 98$ ft. This is the theoretical height to which the liquid refrigerant would be raised but, if we use a safety factor, this figure should be cut down to 80 or 85 ft., the maximum height which would be recommended by manufacturers of equipment used in these systems for 80 lb. condenser pressure. For any lift of refrigerant, the condenser pressure needed will be:

$P = (0.7 \times SO_2 \text{ lift}) +$ friction head in pounds

which allows a factor of safety of 1.14.

In practice, it is customary to employ ½-in. brass tubing for the liquid refrigerant supply lines and ⅝-in. tubing for the vapor return lines as seen in Fig. 3. Both of these should be enclosed in vented conduit or

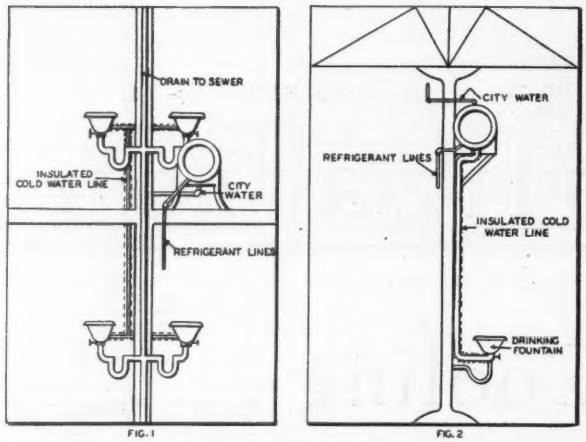


FIG. 1. FLOOR STAND INSTALLATION OF COOLER
FIG. 2. SIDE WALL ARRANGEMENT OF COOLER

loom such as electricians use, in order that any possible gas leakage may be dissipated to the atmosphere. Both supply and return lines may be enclosed in the same insulation and connections concentrated into manifolds to which are connected larger supply and return mains leading from and to the condensing unit.

Individual Coolers

The individual system consists of a number of self-contained units which operate independently of one another and which may be located any distance apart. Each cooler houses its own fractional-horsepower compressor and electric motor. These coolers are manufactured in a wide range of styles and capacities, for operation either under city pressure make-up supply, or for the inverted water bottle where city pressure or drain lines or both are unavailable. The industrial type, adaptable to manufacturing plants, is equipped with either top or side bubbler, also with faucet and may be had with two or more bubblers finished in different colors for use in plants where it is desired to distinguish between users. Office and light manufacturing types

USAGE TABLE FOR DRINKING WATER

Type of user	Temp. Deg. F.	Consumption requirements
Office Bldg.		
Reg. Employees	50	⅛ gal. per hr. per person
*Transients	50	1 gal. per hr. per ea. 250 persons per day
Light manufacturing	50 to 55	1/5 gal. per hr. per person
Heavy manufacturing	50 to 55	¼ gal. per hr. per person
Hotels	50	⅛ gal. per hr. per room, maximum 1½ gal. per day
Schools	50 to 55	⅛ gal. per hr. per student
Hospitals	45 to 50	1/12 gal. per hr. per bed plus ⅛ gal. per hr. per attendant

*Total number of persons entering and leaving office building per day over and above regular employees.

are designed for capacities up to 6 gal. per hr., the industrial type up to 17 gal. per hr., cooled from 80 deg. F. to 50 deg. The principal objection to the individual system is the increased space and cost over what are required for the bubblers of the circulating system. An example of this type cooler is shown in the headpiece.

Initial costs of either the multiple or individual system can be diminished in plants that are divided into a number of departments which are separated by partitions or floors by the use of dead end extensions as indicated in Fig. 1 and the headpiece, thereby causing a single cooler to serve a number of rooms. These extensions may be made to serve any type of fountain.

Compressor Capacity

In calculating the capacity of the compressor for an individual unit with which dead end extensions are to

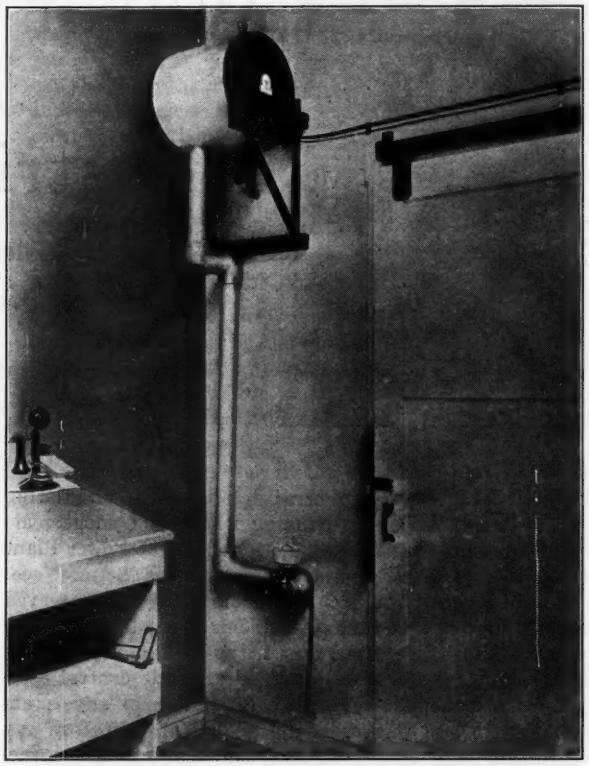


FIG. 3. MULTIPLE COOLER UNIT AND CONNECTIONS

be used, it is necessary to ascertain the line loss of the extensions and combine them with the direct delivery requirements of the bubblers carried on the cooler proper. Due to non-circulation of the water in these extensions, the line losses are high, hence their use is recommended only where the length required is 25 ft. or less. As in the case of the distributing lines of a circulating system, their length and size should be the least practicable.

Assume a cooler unit in either an individual or multiple system, installed as indicated in the headpiece with two dead end extensions of ½-in. pipe totaling 20 ft. of length, insulated with ice-water thickness cork covering or its equal in a building whose average room temperature is 80 deg. F. The cooler proper is to serve 30 persons and each dead end 10 persons, doing light manufacturing. Make-up water temperature is 75 deg. F. and it is to be delivered at 50 deg. What capacity compressor will be required to take care of this load?

It will be observed from the usage table that persons

doing light manufacturing will consume (use and waste) 1/5 gal. of drinking water each per hour. Then the total consumption from the cooler and dead ends is $50 \times 0.20 = 10$ gal. per hr. To lower the temperature of 10 gal. of water 25 deg. F. requires the removal of $10 \times 8.3 \times 25 = 2075$ B.t.u. To this must be added the line losses of the dead ends. Under our conditions of 30 deg. difference between atmospheric and drinking water temperatures, these lines will absorb about 8 B.t.u. per lineal foot per hour, or a total of 160 B.t.u. per hr. which, added to the water-cooling load, gives a total of 2235 B.t.u. per hr. cooling load. A ¾-hp. compressor will take care of this.

Drive for Short-Center, Flat Leather Belts

By J. R. Hopkins

AS SHORT center drives have come into wide use, one of the difficulties encountered with flat belt drives has been to maintain proper belt tension. Gradual elongation, due to atmospheric conditions and belt stretch has required fine and frequent adjustment, which was quite difficult.

In the Rockwood drive, the weight of the motor and proper location of the pivot shaft are utilized to maintain prescribed belt tension at all speeds, regardless of belt stretch. Study and engineering research over a period of 7 yr. have brought the drive to cover the full range of motors and tests at Cornell University have shown an efficiency of 99 per cent, which is maintained under use. Belt slip was under one per cent for full load and not over one per cent for 50 per cent overload, drives being designed to handle 150 per cent of motor rating.

To the floor is bolted a base, held by four bolts and the motor is held by four bolts to a frame pivoted to the base. Adjusting screws permit shifting the pivot shaft bearings so as to aline the motor pulley and driven pulley quickly. Sufficient motion is allowed in the base to take up all belt elongation, design being so worked out that constant belt tension with low bearing pressures will be maintained with center distance varying. Also, when load is removed, the motor can swing to allow the belt to "come back" and rest, a factor which tends to prolong belt life. Flexibility of the drive assists in relieving shock due to widely varying load.

Manufacturers of leather belting, individually and through the American Leather Belting Association have coöperated with Rockwood Engineers in developing belting best suited for short center driving, so that drives are furnished as complete units with full responsibility for successful operation assumed by the sellers.

Six standard sizes of bases fit motors from 1 to 50 hp. at 1800 r.p.m. For larger sizes, up to 500 hp., bases are made to order from welded steel.

Best Performance from Bucket Elevators

FROM 15 YR. experience in selection, construction and maintenance of bucket elevators, Ralph McMillan, construction superintendent of Link-Belt Co., Chicago, emphasizes the following as essentials to secure best performance and long life.

In selecting an elevator, specifications should state the material to be handled, rate of handling and maximum load, also whether increase in load is to be anticipated. Ample space should be provided in the pit to give access for easy adjustments, cleaning and lubrication in the pit around the boot and bottom shaft; also in the casing to avoid wear of bucket and material on the casing.

Positive drive gives best results, designed to eliminate noise and vibration, having pressure lubrication and ample grease or oil storage capacity on take-ups and pillow blocks. Drive casings should be oil and dust tight to give longest service.

Feed to the buckets should be well above the foot shaft so that most of the material goes directly into the buckets. With the centrifugal discharge type, overloading will cause the elevator to choke and stop, hence feed should be uniform and well within elevator capacity. The discharge chute should be of ample size and

FIG. 1. 10-HP. DRIVE, 25 IN. CENTERS, PULLEYS 5¼ AND 28 IN., BELT SPEED 2600 FT. PER MIN.

FIG. 2. 3-HP. DRIVE, 6 FT. CENTERS, PULLEYS 3½ AND 24 IN. SHORTER CENTER COULD BE USED

sloped so that material will pass away freely without danger of backing up to the line of buckets.

When the material is heard dropping down the casing, it is time to stop the elevator and investigate. Adjustment is wrong somewhere and, if the operator cannot locate the difficulty, the elevator manufacturer's engineer or service man should be called on for assistance. Keeping lubrication ample, take-up, feed and discharge properly adjusted and the installation clean of dirt and accumulation of the handled material will contribute greatly to satisfactory performance and long life.

Compressed Air Pressures

By J. W. Romig

POWER INPUT for compressed air is dependent upon efficiency, volume and pressure while power cost will depend upon power input and unit power costs. If the volume at a given pressure is doubled, the power input will be practically doubled. When the pressure is raised, an orifice of constant diameter will discharge more air, more air passes through leaky connections and the net result, if there are many constant area orifices or openings, will be to increase materially the volume and boost the power requirements. On the other hand, if the pressure is decreased from a given pressure, constant area orifices and openings will discharge less air, less will be lost through leaks and less power will be required.

One of the problems of an industrial power plant is to furnish compressed air for various processes at steady designated pressures, determined, in most cases, by experience of operating men on certain machines. It may be that only one machine or one type of machine may require air at the maximum pressure, while all other equipment would operate satisfactorily at a lower pressure. The machine or process requiring full air pressure may soon be obsolete, yet new manufacturing equipment may be purchased for that pressure without consideration of the economic advantages obtainable, if pressures were ultimately lowered. When buying or designing new equipment which uses compressed air, the matter of future as well as existing pressures should be kept in mind.

Compressed air supply may be satisfactory from the operating viewpoint but the cost of the service not given consideration. With re-designed air cylinders or orifices for certain machines, burners, or processes, the pressure might be dropped appreciably and power costs decreased in proportion, the feasibility of such reduction being shown by a pressure-volume investigation of air requirements. Increase of air pressure should be made only after exhaustive studies of pressure-volume requirements, to determine the minimum satisfactory air pressures for each machine or operation in both present and future schemes of operation.

Air pressure study is simple and requires only the installation of a pressure regulator, pressure gage and a tank on a portable platform. Volume requirements are somewhat more difficult but placing a meter in the line between a regulating tank and the regulator is a relatively simple matter. This location for the meter is best because of more constant flow in this line than in the line from the tank to the machine or operation. Tests can be made with the set-up described and the minimum satisfactory pressure for each air-consuming machine or operation may be determined.

In some instances, study of volume requirements with lower pressures will show remarkable decreases in volume with the lowest practical pressure. The results will come under two classifications as follows:

1. The greater proportion of the equipment requires the pressure normally maintained.

2. The greater proportion of the equipment will operate with a pressure lower than the normal pressure.

Changes that are considered practical in cutting compressed air costs are:

a. Alter if economically feasible manufacturing machines or processes so that lower pressures will be satisfactory. Blower air at from a few inches of water pressure up to 3 to 5 lb. has many applications.

b. Divide the discharge lines from air compressors and regulate one line to a lower pressure, thereby decreasing the volume requirements of constant area orifices.

c. Keep leaks repaired and have the area of constant area orifices as small as possible to give the desired results.

d. Install a low-pressure compressed air system independent of the existing system, the pressure and volume to depend upon results of pressure and volume investigations made with the test setup.

Changes involving lower pressures should be carefully studied so that production will not be jeopardized. In every case, studies will show just what can be done and, with the test equipment, machine operation can be maintained for a sufficient period under production conditions so that decisions reached as to lowest permissible pressures will be sound.

The theoretical power requirements for air compression at various pressures are shown in Table I.

Table I. Horsepower per 1000 cu. ft. per min. Adiabatic compression, 15 per cent friction

Pressure lb. gage	Single stage	2-stage
10	40	
20	70	
30	96	
40	118	
50	136	123
60	153	136
70	168	147
80	182	158
90	195	167
100	207	176

Marked increase in power is shown as the pressure increases. For instance, the difference in power input for 1000 cu. ft. of air at 100 lb. and at 40 lb. gage is 89 hp., an increase of 75 per cent over that for 40 lb. The volume discharge into the atmosphere through a constant area orifice ⅛ in. in diameter at 40 lb. is 12 cu. ft. per minute, at 100 lb. is 26 cu. ft. per minute. Unless the higher pressure is needed for the orifice to function, the volume loss amounts to 14 cu. ft. of air per minute which represents unnecessary power cost. A 1000-cu. ft. compressor would supply thirty ⅛-in. orifices at 100 lb. and 83 such orifices at 40 lb.

To show the possibilities of compressed air studies, an example based on the following information is worked out. Capacity of 3000 cu. ft. is required at 40 lb. A

survey shows that, of the total volume, 1000 cu. ft. of air at 20 lb. will replace 1200 cu. ft. of the 40-lb. air. The economy of a second air pressure may be developed or a regulating valve may be considered. A regulating valve piping to equipment that will operate with 20 lb. air will reduce the volume required by 200 ft., the power by 23 hp. or 17 kw. With power at $0.01 per kw-hr. for 300 days, 24 hours per day, the power saving will be $1225 per year for 1000 cu. ft. used per minute. This will justify a considerable investment in low-pressure piping and a pressure regulator. Consider the installation of a 20-lb. compressor air system in addition to the 40-lb. system to replace a portion of the 40-lb. supply. The additional saving over that shown above is 118 — 70 = 48 hp. or 35.5 kw. which amounts to $2550 per year of 300 days, 24 hr. per day, with power at one cent per kilowatt-hour for 1000 cu. ft. used per minute.

The above development, on a theoretical basis, does not apply directly in case of actual operation but merely shows the possibilities and should not be considered as final. Each compressor has its own operating characteristics, a certain power input for no load with power increasing as the unit is required to furnish air. In figuring the economics of a unit, the power reduction will be only the difference between the total power input under the normal condition and under the condition when the volume is reduced. With the new compressor for a lower pressure, a certain amount of power would be required to overcome the friction and a certain additional amount for the air demand. It is therefore essential, in considering an actual installation, to secure complete power input information on existing machines together with the same information on new machines that are being considered. Having this information, the final economy may be developed and the wisdom of an investment determined on a sound basis. Economic saving will be greater the higher the power costs and the lower the pressure that may be satisfactorily substituted for the existing pressure.

Where, as in many cases two pressures exist in a plant, savings may be possible without installing additional compressors. Suppose that there is a 100-lb. air supply with some excess compressor capacity, in addition to a 40-lb. supply. Tests may show that but a small amount of air is required at 40 lb. and most of the air could be supplied at 20 lb. with good results. If there is sufficient excess capacity at 100 lb., it may be economical to transfer the small service actually required at 40 lb. to the 100-lb. supply, then operate the 40-lb. compressors at 20 lb. This is another angle for considering unusual phases of compressed air problems.

If two or more compressors operate at 40 lb. and a considerable proportion could be utilized at 20 lb. it may be wise to install separate air lines and operate with two pressures. It is also possible to interconnect the air lines so that, in case of inadequate 20-lb. air supply, some 40-lb. air could be turned into the low pressure line by means of an automatic regulator.

In one particular instance, low-pressure air at slightly over ½ lb. replaced 25-lb. air after some changes had been made in piping and in auxiliary equipment, with material reduction in power input. Of course, many compressed air systems do not offer sufficient possibilities to justify any appreciable investment; but, it is desirable to know just what can be done and tests are recommended in any plant where considerable amount of compressed air volumes are used.

In any plant, studies of compressed air uses lead to a better understanding of pressures and volumes needed. It is then possible to make plans for future installations of air compressors with complete knowledge of requirements for each particular phase of operation. Also, studies of volume have a value in the distribution of compressed air cost to the various operations in proportion to consumption which will induce greater care in the use of air, hence less cost for power.

Pupin Wins Fritz Medal

JOHN FRITZ Gold Medal, highest of American engineering honors, has been awarded for 1932 to Dr. Michael I. Pupin of Columbia University for his achievements as "scientist, engineer, author, inventor of the tuning of oscillating circuits and the loading of telephone circuits by inductance coils," it is announced.

The award, which was unanimous, was made by a board representing the four national societies of civil, mining and metallurgical, mechanical, and electrical engineers, having a membership of more than 60,000.

Dr. Pupin is professor of electro-mechanics and director of the Phoenix Research Laboratory at Columbia. Among engineers and scientists he is widely known for his researches and inventions in connection with long distance telephone lines and for his advanced work in the passage of electricity through gases, electrical resonance, electrical wave transmission over long conductors and many other scientific subjects.

He was born a Serb in a province of Hungary, October 4, 1858. He came to America as a boy and after many courageous struggles won an opportunity for an education. He was graduated from Columbia in 1883, studied at the University of Berlin, and received the degree of Doctor of Philosophy in 1889. He is a Doctor of Science of Columbia and Princeton Universities, and a Doctor of Laws of Johns-Hopkins University, New York University, Muhlenberg College and other institutions.

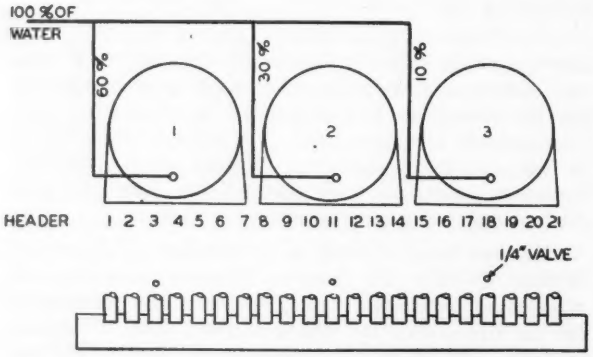
Dr. Pupin is a past president of both the American Institute of Electrical Engineers and the American Association for the Advancement of Science. He is a member of the National Academy of Sciences, the New York Academy of Sciences, the American Philosophical Society, the American Physical Society and other learned bodies, and a past chairman of the Engineering Foundation.

Dr. Pupin has received numerous other honors, including the Edison Medal of the American Institute of Electrical Engineers and the Carson Gold Medal of the Franklin Institute. During the war, he served on the National Advisory Committee for Aeronautics and other bodies doing scientific research work to aid the Government. His home is in Norfolk, Litchfield County, Conn.

Among the recipients of the John Fritz Gold Medal have been President Herbert Hoover, Admiral David Watson Taylor, Retired, of the U. S. Navy, Ralph Modjeski, John J. Carty, John F. Stevens, Ambrose Swasey, Guglielmo Marconi, Sir Robert Hadfield and Charles P. E. Schneider.

Poor Feedwater Distribution in Boilers

IN A STEAM ELECTRIC generating station, the writer found on taking charge that the tube renewals in the bottom rows of some three longitudinal steam drum boilers were excessive. The boilers were set in



BECAUSE OF THE LOW FEED TO NO. 3, THE WATER LEVEL WAS EQUALIZED BY FLOW THROUGH THE MUD DRUM RESULTING IN HIGH CONCENTRATIONS AND TUBE FAILURES

the regular way, two boilers in a battery with the tubes about eight feet above the grates and fired by a well known underfeed stoker. They were called on to carry peak loads of approximately 250 per cent of their rating. This rating was not high, but it was thought that owing to the low setting, a "blow torch" effect might be the cause of the failures. After tabulating the renewals, however, it was seen that all but one of the renewals were under the No. 3 drum.

Feedwater piping on each battery was the same, the connection being taken from the main through regulating control valves and distributed to the drums by separate lines. As the last drum to be fed from the distributing lines was the one that showed the greatest tube renewal, as well as the greatest amount of scale in the tubes, the distributing system was considered as a contributing cause by giving unequal distribution of the water.

To find out whether there was actually an unequal distribution of the water in the drums, the writer then made a sketch of the drums as shown with the feedwater connections and directly below the connections to the mud drum.

Samples of the water in the three drums was then obtained by drilling a hole in one of the tube caps in a header connecting to each of the drums and installing a ¼-in. valve. Samples were taken after the boiler had been on the line for about three weeks and the samples showed that the water in No. 3 drum was very salty with considerable impurities; the center drum showed less salt with the water quite clean and the No. 1 drum showed very clear with practically no salt.

To prove that faulty water distribution was the cause of this difference, it was decided to close the combination valve on the feed line entering No. 1 drum (to which the water column was attached) and see what would take place.

Samples were taken again in about 5 hr.; No. 1 drum was found to have the same condition as No. 3 previously had; the center drum was about the same as before, while No. 3 drum was fresh with as few impurities as No. 1 had before. This satisfied me that No. 1 drum was normally receiving most of the water and this kept the drum fresh all of the time. Number 3 drum was receiving much less than its share, less than either of the other drums so the water level equalized with the other drums by obtaining the greater part of its water from the other drums through the mud drum. Impurities collected and were held in No. 3 drum with the result that the higher concentration caused scale more quickly. Knowing the cause, the trouble was soon remedied.

Cambridge, Mass. M. W. EASTMAN.

Utilization of Boiler Plant Losses

I HAVE read with interest the article, "Insulation for Tops of Boilers," by R. H. Beal in the September 15 number. Almost anybody having occasion to work on top of a boiler will agree with Mr. Beal, that this radiation loss is a neglected opportunity and not much effort is usually made to save this heat, especially in low pressure steel heating boilers and it is along this line that a sizable saving may be made, by salvaging the waste heat, not only from the boiler top but from the breeching, side walls and other hot spots.

Insulation of asbestos and waterproof cement, as suggested by Mr. Beal, will prevent much of the heat loss from the boiler top, but, aside from the element of danger of water damage, this insulation is not always suitable where work must be done on the boiler top, such as the manipulation and maintenance of valves and general routine work that requires access to all parts

of the boiler top on a solid footing, often in a minimum of time.

This overheating is not always preventable with existing equipment, yet it may be minimized and savings established with intelligent designing of new installations and economical ways of removing it in existing installations.

Proper proportioning of the boiler capacity in more than one unit will reduce this radiation loss by having a capacity about equal to the requirements operating. Many installations of steel heating boilers are much too large for the load they carry on an average; they are often proportioned in a single unit for a peak load that occurs but a few days of a heating season. To keep the steam pressure within certain limits, the engineer is forced to run with banked fires the greater part of the heating season.

If a boiler is already installed, air insulation that removes this excess heat and uses it for a heating or drying operation provides an economical means of preventing overheating of the boiler top.

The general principle of this scheme consists of enclosing the boiler top in a chamber, six feet tall, if the space provides. Besides the boiler this chamber will include a short section of the steam main, and valuable heating surface may be added by enclosing some of the breeching and side walls. A fan connected to this chamber discharging into a transmission duct that will transmit the excess heat to a point where it may be used to advantage.

Air entering the casing may be through grill panels in an inspection door or if the side walls are included, the air may enter through grills about 2 ft. above the floor line. The heat that is intercepted by this air is mostly absorbed and but a small part is radiated through the chamber casing. The water vapor in the air around most boiler rooms is usually high, caused by leaky glands, sweating pipes and pumps. This highly moistened air forms a large part of the atmosphere in the chamber and being highly absorbent to heat, provides an excellent means of preventing overheating.

Brooklyn, N. Y. WILLIAM ANDERSON.

Fixed Charges vs. Operating Expense

FIXED CHARGES are a stumbling block for many of us and of these depreciation is the most bothersome, usually bobbing up behind the bookkeeper's shoulder when you have some carefully prepared plan for improvement up with the "big boss." It is surprising how the "book value" of old or obsolete equipment can spoil a good scheme. Of course this need not interfere with the figuring but it is a factor which will not be overlooked by the management. The article by Mr. Henschel in the July 15 issue is good and I hope that it will be followed by some discussion on the matter which will enlighten those who have old equipment and who find the matter of book value coming up to puncture arguments for replacement that seem good and sound.

First as to depreciation, I would not attempt to argue with the author, who obviously knows what he is talking about. The fact that no depreciation rules have been universally adopted seems to indicate that there is a difference of opinion. Where a sinking fund is set aside and invested in stable bonds, the method used is surely correct. But often we do not have that situation in business. A depreciation reserve is set up and theoretically should draw interest but is not actually invested in interest-bearing securities. If it were, the company would be lending money at 5 or 6 per cent and having to turn around and borrow money for short terms at 8 or 10 per cent to carry on necessary expansions. The depreciation rate is so low that the equipment has a considerable book value when it is actually obsolete; not worn out but uneconomical.

As to the straight line method, it seems to me that the author was not quite fair in the example given. If the first cost was $1000 and the scrap value at the end of ten years $100, why not set aside $(1000 - 100) \div 10 = \$90$ a year. This would give with interest $286.36 excess instead of $418.08 at the end of the 10-yr. period. But these figures consider compound interest and where is the company that sets up a sinking fund and credits to it the depreciation reserve interest. Theory and practice of the reserve are not identical. If they were, even though depreciation were taken as 100 per cent, the complete value would be written off the books before the end of the eighth year, thus reducing operating expenses, yet leaving the scrap value of the old machine as an asset toward reducing the cost of a new one.

Then there is the fixed percentage method wherein the depreciation is taken as a fixed percentage, not of the first cost, as in the sinking fund method but of the current book value. The depreciation is large during the first years and less in the later years. The advantage is that, when the machine is new, the depreciation is large and the maintenance small; when the machine is old, the depreciation is small and the maintenance large, thus giving about uniform fixed charges throughout. Theory again. The maintenance always seems to come in a lump to spoil an otherwise low yearly cost. These matters are explained in some detail in Goodman's book mentioned in the article.

As I understand it, the sinking fund method makes the sum of interest and depreciation a constant; the fixed percentage method keeps the cost of depreciation and maintenance a constant; the straight line method comes nearest to keeping the sum of interest, depreciation and maintenance a constant. But interest is not figured in as an operating cost by the bookkeeper. If a million dollars has been invested in a business, the interest on that million is not figured as an operating cost of the plant, although it may be considered in making comparisons. Of the three, the fixed percentage method seems to me to be the best for the operator.

There is still another which, I believe, is approved for income tax returns and thus deserves consideration. It is depreciation based on output. Naturally, we would expect the depreciation to be much greater on a machine that was working to capacity all the time. Why not make the depreciation proportional to the output? Of course obsolescence comes into the picture and is not taken into account by any method, otherwise this seems to be the fair one. Certainly it is logical from the business standpoint because it means that the greatest depreciation is taken in prosperous years when it can be borne and, in the lean years, the lightened depreciation may mean the difference between a slight profit and a loss.

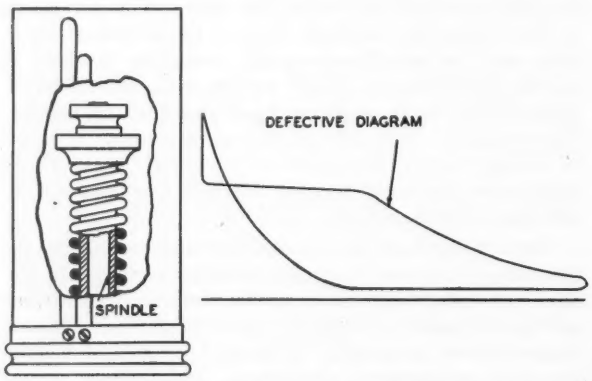
In figuring on new equipment, it seems to me that leaving out interest charges and figuring the problem

on the basis of the annual return on the investment is the best method. Usually a proposition can be reduced to two possibilities which makes this convenient and logical. If A costs a certain amount and B is more efficient but costs more money, it is simple to calculate the return on the extra investment for B. Inasmuch as the books show no interest charges, it seems foolish to assume that you have a certain amount of money (which you probably have not) that, if you didn't use to buy equipment, you could invest at 6 per cent and then figure this interest as an operating charge. As a matter of fact, you have to go out and borrow it and pay 8 or 9 per cent. If you can figure to get a return of 18 or 20 per cent from it in the equipment, you have a pretty good idea that the extra return on the investment is worth taking a chance on. It would be just as logical to take this 9 or 10 per cent profit on the borrowed money and figure it as a reduction of operating expense as it is to figure in the interest on an investment as operating expense.

Brooklyn, N. Y. P. F. Rogers.

Indicator Defect Causes False Diagram

In a factory power plant containing a pair of high-speed automatic-cutoff engines, the operating man in charge was accustomed to taking indicator diagrams from the engines weekly. His purpose was to discover promptly any let-down that might have occurred in the economy of steam distribution. On one occasion, while following his usual schedule, he got from the first of the two engines the diagram shown at the right in the accompanying sketch. This seemed to indicate a defect in the valve-setting but the diagrams taken the previous week showed no such disorder and the engine now gave no sign, by sound or otherwise, that anything was wrong.



STICKING DRUM CAUSED ERROR IN DIAGRAM

Without attempting to correct the apparent defect, the engineer shifted his indicator to the other engine. He got a second diagram showing the same deformity as for the first one, then concluded that something was wrong with the indicator and so it proved.

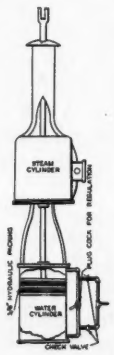
Examination showed the trouble to be due to the paper drum not rotating freely upon its spindle. When it was turned to the limit of the forward stroke, it stuck momentarily at this point, due to frictional resistance, before starting the reverse rotation. The drum was of the type in which a helical spring acts against the pull of the cord, as shown at the left in the sketch. Applying a little lubrication to the interior rubbing parts corrected the trouble.

Going over the diagrams he had on file from previous applications of the indicator, the engineer found that the compression curve on most of them showed more or less variation from the curve obtained after the impediment to free movement of the paper drum had been removed. It may be that insufficient spring tension and a slightly sticky condition at the paper drum's axis of rotation causes many old and neglected indicators to tell a misleading story regarding events inside the engine cylinder.

St. Louis, Mo. D. J. Altizer.

Packing Friction Interferes with Stoker Speed Regulation

We operate two stokers of the overfeed type, using steam and water in the motor. The steam furnishes the power and the water is used for speed regulation. When new, they worked nicely but later we were unable to regulate the speed so I took one down and found the packing in the motor cylinder worn out. I replaced it with new packing but after a couple of hours we were unable to regulate. I took this motor down again and an examination revealed the packing had expanded making it too tight. I reduced the packing thickness enough to make a loose fit and our troubles were over.



SECTION OF HYDRAULIC CYLINDER THAT GAVE TROUBLE

Mechanicsville, N. Y. R. F. Leach.

By a large majority, the employes of General Electric Co. have voted to accept the unemployment relief plan proposed by President Gerard Swope. Of the 39,000 employes eligible to the plan 35,000 have so far voted for acceptance with some absentees to be heard from.

As of Nov. 1 and following, available work for piecework and hourly-rate employes will be rotated so that each will receive, for the ensuing 6 mo. at least, half his average full time earnings up to $15 a week and more than $15 a week if actually earned. Those earning 50 per cent or more of full time earnings including salaried employes and officials are to contribute 2 per cent of their earnings, the company to contribute a like amount to the unemployment fund. If this proves inadequate, the board of directors of the company will be asked to increase its payment without additional contribution from employes.

Questions and Answers

Heat Required for Melting Ice Cream

MELTING IS DONE in a vat containing 1000 gal. of mixed ice cream, which weighs 9 lb. per gal. at 32 deg. F., by steam from an 8-in. main line at 125 lb. pressure reduced to 10 lb. on a 3-in. line to the vat and a 3-in. return line leads to the hot water tank. How much steam is required to raise the temperature in the vat to 160 deg. F. in 40 min. time? S. H. C.

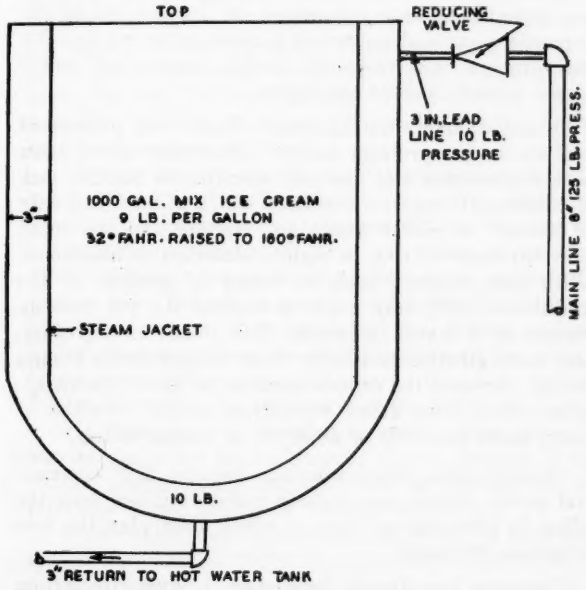


DIAGRAM OF STEAM JACKETED VAT

A. The formula for determining the amount of heat required to raise w lb. of a substance from t_1 to t_2 is $Q = wc\ (t_2 - t_1)$ where c is considered as the specific heat of the substance and as having a constant value.

In general, c varies with the temperature, though for moderate temperature ranges a constant mean value may be taken.

Substituting in the formula the values given in your letter and 0.78 the specific heat of ice cream, we have:

$Q = 9000 \times 0.78\ (160 - 32)$

$Q = 898{,}560$ B.t.u. the amount of heat necessary to raise 9000 lb. of the mixture from 32 deg. F. to 160 deg. F.

The total heat of steam in B.t.u. at 125 lb. gage is 1192.4. We must assume some temperature for the water in your return lines so we have taken it as being 200 deg. F. This will leave us $1192 - (200 - 32) = 1024$ B.t.u. available to heat the ice cream mix.

Dividing 898,560 by 1024, we have 877.5 lb. of steam necessary to heat 9000 lb. of mix from 32 deg. F. to 160 deg. F. Time does not enter into the foregoing calculation except that the return water temperature assumed may be off and will vary with the rate at which the cream is heated. The temperature difference assumed $(200 - 160 = 40$ deg.) is sufficient to give rapid heat transfer but any variation in the amount of steam required due to a change in the time of heating will probably not be more than 3 per cent from the figure given above.

Problems Encountered by Boiler Attendant

WHAT SHOULD be done if you discover a crack in the shell of a boiler?

2. Why is it very necessary that the fire door arches under a horizontal tubular boiler should be kept in good condition?

3. State how you would put the manhole plates back in a boiler. Give details.

4. Why is it important to keep the face of the bridge wall clean and free from ashes and clinkers? R. B.

A. When a crack appears, the boiler must be kept out of service until the affected parts have been repaired or replaced. No welding or patching should be done except upon and in accordance with the advice of an authorized boiler inspector.

2. To prevent furnace gases from passing direct to the breeching without going through the tubes.

3. The gasket should be inspected and, if faulty, replaced by a new one. The face of the manhole cover upon which the gasket rests should then be cleaned of any foreign material such as scale or dirt; by rubbing with emery cloth if necessary. The same should be done to the flange on the boiler shell, which comes in contact with the other face of the gasket. When both are clean, the plate, if oval should be turned in such a way that the shorter axis of the ellipse lies along the longer axis of the opening. It may then be placed on the inside and with the gasket in its proper position in relation to both the cover and the flange on the manhole, the yokes and bolts are then put in place and tightened.

4. The face of the bridge wall should be kept free of ashes and clinkers because under high temperature these melt and form slag that unites with the brick work of the wall and causes it to chip and deteriorate gradually.

FROM THE installation of flow meters on steam, air, gas, water, oil, and other lines you can reasonably expect to get information which will point the way to a bettering of the operating efficiency of your plant. Industrial plants measuring flow to individual departments or manufacturing units can accurately allocate costs of operation from the meter totals. Disputes between department heads and power supervisors are settled and wasteful practices and non-profitable departments studied.

Editorial Comment

Progress in Vertical Transportation

Recent announcements of new types of elevators, installed and contemplated, have aroused considerable speculation among power engineers and building designers as to their possible effects on the economics of high buildings. One of the most important factors influencing the height of commercial buildings in the past has been the limitation imposed by the high ratio of elevator area to rentable space. Some time ago, however, the Westinghouse Electric & Manufacturing Co. announced the installation in one of its buildings of a double-car installation, in which an express car and a local car operate in the same shaft. At the same time, there was consideration of the double-deck elevator car. An installation of double-deck cars, as described elsewhere in this issue, has recently been made by the Otis Elevator Co. in the 67-story Cities Service Building in New York. It is understood that special provisions have been made in the elevator code to permit this installation.

Zoning laws in New York and other large cities often reduce tower areas to such an extent that equally undesirable alternatives result; either the elevators require so much floor area that adequate rentable space cannot be obtained on the tower floors or the number of elevators is reduced at the expense of good service. For some time it has been felt by architects and engineers that increasing the handling capacity of an elevator shaft was the only way out of the difficulty. Experiments in double-car and double-deck elevatoring have been in progress for the last few years, simultaneously with the movement to have the code revised to permit that type of installation.

Apart from the engineering achievement of the manufacturers in perfecting these two types of elevators, their successful operation will have a tremendous influence upon tall building design and construction.

In the Cities Service Building, for example, before the elevator code had been revised, it was deemed necessary to install 14 single-deck elevators to serve the floors which will now be served by the eight double-deck elevators. When it is considered that each shaft requires approximately 50 sq. ft. of space on every floor to the top of the building, it will be seen what a saving of floor space was afforded by the installation. Six less shafts, 50 sq. ft. each, 60 stories—the result is a saving of 18,000 sq. ft. On the current basis of $3.50 per sq. ft. in the new buildings in the financial district, the probable increased revenue would be $63,000. Much the same reasoning applies to the double-car arrangement.

The effect of these new types of elevators upon growth in the height of buildings is not determinable, of course, since so many other factors of economics enter into the decision. It appears, nevertheless, that the ability to conserve elevator space by the above methods will lead to new analyses of the economics of high buildings and may eventually prove an important factor leading to the design of buildings much higher than those we have at present.

The Future of Flue Gas

Aside from the ash, dust and soot from the flue gases, objectionable odors, commonly referred to as noxious gases, are receiving increased attention from regulatory bodies acting under the general title of smoke abatement.

Some few of these bodies under competent engineering supervision have recognized the importance of the domestic plant and industrial furnace in trying to solve this problem, but from the public, commercial power plants receive most of the blame.

Unquestionably the discharge of ash from pulverized coal stacks is a problem not yet completely solved from both engineering and financial standpoints but the lack of equipment creates a condition which at most can only be classed as mildly annoying. Neither can the small concentrations of CO_2 be rightly classified as obnoxious. With high sulphur coals as found in sections of the middlewest, SO_2 may reach as high as 0.5 per cent by volume as it leaves the stack. This is not an objectionable concentration and is far from dangerous to human beings. Around the copper smelters, sulphur concentrations which have killed vegetation within a radius of many miles has little or no effect on human beings.

Nevertheless public relations demand that commercial power plants, particularly public utilities, lead the effort to solve the problem in which they play the role of minor offenders.

Progress has already been made in dust elimination while recent developments indicate that both CO_2 and SO_2 can be taken successfully from the flue gases. As yet the process is experimental and probably expensive. In spite of this, an offer has already been made to build a power plant as a byproduct of the recovery of CO_2 from the flue gas. With a steadily increasing demand for solid CO_2 and a market for sulphuric acid as well as SO_2, the equipment for extracting these compounds may be made to pay for itself.

In addition, the solidification of CO_2 requires considerable power and this offers an opportunity of filling in the early morning valleys in the power load curve. Carbon dioxide collected during the heavy load hours could be solidified during the periods of light load to improve load conditions greatly.

In many industrial developments, the tail often grows to such proportions that it wags the dog and saving the byproduct of flue gases, forced on the power plant by popular opinion, may yet grow to such proportions that the production of power is merely a by-product of the manufacture of carbon and sulphur products.

Thomas Alva Edison Off Duty

Thomas Alva Edison is dead. The final chapter in the eventful life of the great inventor has been written and now, after 84 years, he who so assiduously scorned rest is "Off Duty." His work is done; he sleeps.

Since the dawn of history, no man's death has been mourned by so many. For upwards of half a century, throughout the civilized world, the name of Edison has been a household word, a symbol of the scientific progress of the age; his fame has inspired the boyhood ambitions of countless youths who found fascination in the mystery of an electric bell or in the cryptic language of a telegraph sounder. Indeed, to the masses, the name of Edison was synonymous with electricity. It is not strange, then, that such a personality should be mourned. More than anyone else, Thomas Edison was the embodiment of the spirit of achievement.

Yet, with all his fame, he was something of an enigma. Though he was a world figure for upward of fifty years; though the influence of his work has contributed, directly or indirectly, to the well-being of nearly all civilized people; though he was known in every hamlet in every land from Siberia to Cape Town, just who was this man, Edison? What manner of man was this, who by the sheer force of his brain so influenced our manner of living?

Despite the fact that he was "front page news" for many years and that the results of his labors are known to every intelligent person, Thomas Edison remains one of the strangest figures of our time—a man of mystery; aloof, enigmatic, unamenable to the rule of averages in human life. Though he surrounded himself with assistants who tried out the almost continual stream of ideas which emanated from his brain throughout his life, in many ways Edison led a life apart. He cared nothing for the pleasures, the ambitions, or the follies of average human nature. Never tempted by money, fame, glory or honors, for years he deliberately denied himself to the public, unless sought out and then he usually cut the interview short, ostensibly because of business.

Fine clothes were wasted on him, and if a king presented him with a medal incrusted with diamonds, he would glance at it indifferently and put it away in a box, never to think of it again. At the close of the exposition at Paris in 1889, Edison was made a commander of the Legion of Honor and . . . "they tried to put a sash on me," he said, "but I couldn't stand for that." He avoided all formal social functions. Instead, he preferred to hang over a machine, lost in thought over its workings—his clothes stained with acids, his hands grimy with oil. And when night came, his great abstraction would keep him at his work through long, sleepless nights.

To attempt to measure such a man by any ordinary standards of human values is, of course, absurd. Although he has been held up as a model to guide the course of all those who wish to succeed, Edison's career is, in the main, a deadly rebuke to the cocksure conformists who owlishly advise us on how to gain success. Edison was no ordinary man and no ordinary man endowed with the normal instinct for pleasure, social companionship and leisure could succeed by the methods which Edison, by nature, employed throughout his long life.

In consequence of his exceptional powers and his non-conformist nature, coupled with the inability of ordinary human beings to understand such a personality, a mythical Edison has arisen in the eyes and minds of the public. This has been enhanced by the newspapers. Edison always was "good copy" and since the dear public was always ready to expect the marvelous from Edison, the inspired knights of the press never failed to supply the marvels, often to the displeasure and annoyance of the inventor.

Edison's supreme gift was his infinite power of mental concentration, backed by a mind whose gifts are perhaps best described by the word genius. He worked with concentrated steadiness and interminable patience; failure never seemed to discourage him. There was a temperament expressed in his remark, "spilt milk doesn't interest me." Yet, despite his intense application, he worked with an "easy tempo;" nobody, it seems, ever saw Edison in a hurry.

Misconceptions have been common as to how Edison arrived at his results and in general these may be classed as two varieties: those which held that he was guided by sudden bursts of supreme insight (the wizard myth) and those which held that he was a cut and try experimenter, trying everything, hit or miss.

Now, as a matter of fact, Edison's method in developing an idea was largely a method of elimination. He usually started out in absolute indifference to whatever difficulty theoretically existed but before doing so, he thoroughly studied what previously had been learned and done. Then, his assistants tried things, recording their experiments in laboratory note books. Though he was no slave to theory, he never ignored what had been done before. His vast scientific library at West Orange is ample testimony to his interest in what others did. Thus, by gradually determining what could and what could not be done, he developed his idea to successful completion—or, perhaps, to unsuccessful termination.

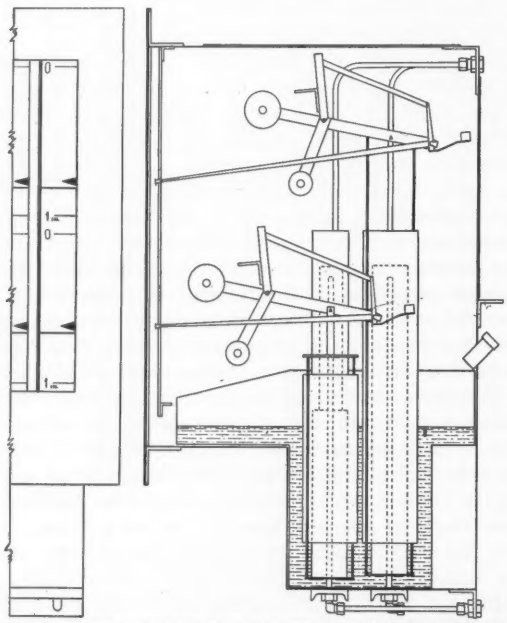
For, notwithstanding the fact that he was a genius, Edison was human and, if we may say so without intending disparagement, had human failings. Though he was possessed of infinite patience, this patience applied only to his labors. With those about him, particularly those who were not very keen, he had no patience, whatever. Nor was he always consistent. His opinions on matters outside of his work were often inconsiderate and prejudiced. He little understood the desires and passions of average human beings and was, by nature, of the "reformer" type of mind. Thus, it is not altogether surprising to find him disparaging the cultural side of American life; nor was it surprising to find him inexorable toward the cigarette, though he had been a steadfast chewer of tobacco and at one time smoked twenty strong cigars a day. It was, however, surprising to find him pooh-poohing mathematics, though he had been able to obtain the services of mathematicians when needed.

In a way, these qualities of Edison are reassuring, for they show that he was human and after all, we would like to think of him as so. To paint him as a human being need not detract from his greatness. All great men are subject to hero worship which sooner or later kills the personality involved and sets up a wax figure in its place. So, today, while we still have before us a real Edison, a personality with some of the frailties which makes us humans, let us consider him dispassionately and record his character as he was, so that we may still know him when his name and fame are but distant memories. To do this is to honor him. For Thomas Edison was a great man.

Power Plant Engineering Developments and News

Tandem Pointer Draft Gages

NEW TANDEM SYSTEM of Ellison pointer draft gage straight-line movement is designed for zoned air flow control under large forced draft stokers. As an example of a typical requirement, there is now under consideration a proposal to furnish zoned air flow



TANDEM SYSTEM OF DRAFT GAGES FOR ZONED AIR FLOW CONTROL

control boards for Taylor stokers, 16 retorts wide. Specifications provide for four zones under retorts and four divisions under extension grate, requiring 68 air flow readings.

To provide a compact gage with minimum space requirement, standard movements as furnished in the Ellison pointer draft gage straight-line movement are arranged in pairs with two rows of pointers in the unit one above the other in the same casing and with the bells one in back of the other in the same oil pan. Scale centers are 2¾ in. or an equivalent space requirement of 1⅜ in. width for each reading. A minimum of height is required with this arrangement, since seal provision for maximum static pressure of lower forward row of elements likewise serves the upper row as well.

Extension type differential elements projecting above the beam are provided to afford protection against high induced draft statics. Depth of drop leg is dependent only on maximum forced draft static for which gage is to be sealed.

The double row of pointers readily divides into zone grouping; i. e., top row to show forward zone of all retorts, bottom row the lower zones. To indicate the division between the extension grate and the retort zones, the blinder between these scales is finished in black, all the other blinders in aluminum.

All bells are served by a common oil pan or reservoir, provided with oil filler in back of gage through which oil level may be seen on a marker. Drain is provided on bottom of pan and piped through the supporting plate in back of the casing. Pressure connections are also supported on the back of the casing with fittings tapped ⅛ in. I.P.T. for connecting pipe lines. Shut-off cocks are furnished for each pipe line.

The usual range required is +1 in. of water differential, sealed as specified for maximum induced and forced draft statics. Scale for each pointer is 8 in. long, the two scales for each pair of pointers being combined in one piece. Scales may be furnished in square root graduations for direct indication of relative air flow, in uniformly spaced graduations, or graduated only at zero and full range as specified.

Movable markers, consisting of a metal strip ⅛ in. wide across the scale, are provided for adjusting pressure curves on the scales, to serve as a guide for the stoker operator to maintain correct air flow for any given rating or operating condition.

The gage is manufactured by the Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill.

Watthour Meter Test Set

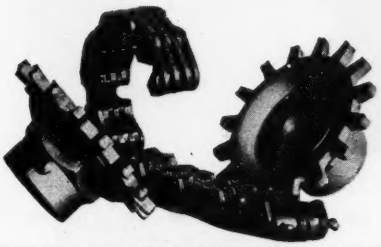
FOR CHECKING the connection of 2- or 3-phase, 3-wire and 3-phase, 4-wire circuits, the Weston Electrical Instrument Corp., Newark, N. J.. developed a model 551 watthour meter test set. No technical knowledge is required by the individual when using this set. The operator simply makes a routine test and records the data on a standard form from which vector diagrams can be readily prepared and test results quickly analyzed. The device is so designed that the test is automatically cross-checked. Any errors made by the operator, such as incorrectly connecting the test set or recording the watt meter readings, will be detected when the data are analyzed. The transformer connection test will show up defects in instrument current transformers even where such defects affect the watthour meter in amounts as small as 1 per cent. Primary load and power factor for each phase is measured in the test. Such information is frequently desirable for reasons other than for which the test was made. The indicating wattmeters, voltmeters, ammeters, and power

factor meters connected in the same circuit may be checked by means of this test set at the time the test is made.

Midget Coupling

SHAFT FLEXIBILITY in power transmission is fast becoming a major factor for consideration in small horsepower installations. The high cost of worn bearings due to misalinement and general machinery depreciation due to vibration, as well as costly breakdowns and delays due to these inefficiencies, are comparatively just as important on the small installations as on the 5000-hp. jobs.

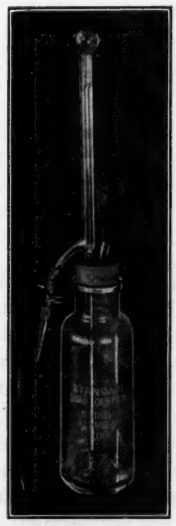
The big problem among flexible coupling manufacturers has been to design a practical coupling that can



CHAIN AND TWO SPROCKETS FORM COUPLING

be supplied at low cost. The new Morse Midget recently placed on the market is a miniature counterpart of the Morse Chain-and-Sprocket coupling used on installations up to 5000 hp. The manufacturer, the Morse Chain Co., Ithaca, N. Y., Division of Borg-Warner Corp., states that the simplicity of design—two sprockets wrapped by a chain—has withstood the most strenuous tests in constant operation in numerous lines of business over a period of years. The new Midget coupling is designed for shaft sizes up to one inch in diameter and has all steel construction to give trouble-free service with exceptionally long life.

Self-Leveling Burette



SELF-LEVELING BURETTE

IMPROVEMENT in self-leveling burettes has been brought out by the National Aluminate Corp., of Chicago, Ill., and is shown in the accompanying illustration. The advantage of this burette over its predecessor, it is claimed, is its compactness and simplicity.

It is 16½ in. high and the reservoir will hold 500 cc. The reservoirs are marked for soap, acid and silver nitrate, the latter being a brown bottle to keep out light.

This burette itself contains 10 cc. and is standard equipment in all the water testing kits now being distributed by National Aluminate Corp. excepting the traveling kit.

Vertical Spiral Bevel Gear Speed Reducer

NEW SPEED REDUCER of the vertical spiral bevel type is announced by the D. O. James Manufacturing Co. of Chicago, Ill. This unit is designed for smooth, noiseless operation and several novel advantages of design are claimed for it. Gears are made of chrome nickel of spiral bevel type to secure greater efficiency from the improved tooth form, which is intended to provide more teeth in constant contact and a greater tooth bearing or pressure area in each tooth of given size. High efficiency and a greater delivery of input power are thus obtained, it is stated.

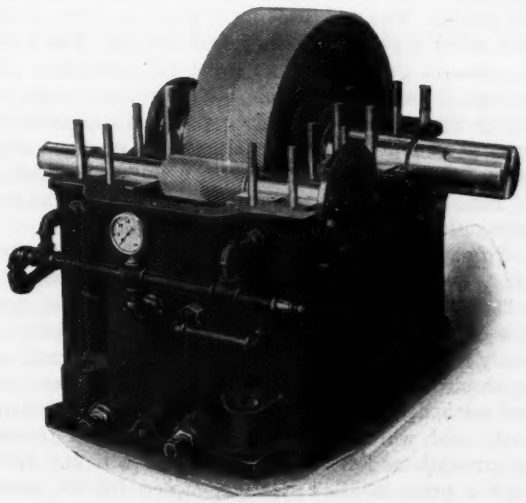
Shafts are made of 40 carbon steel and roller bearings are provided on both drive and driven shafts. Where large ratios of reduction are required, this type of reducer is made integral with a planetary reduction unit so that all ratios from 8 to 1 to 1600 to 1 are available. They are made in sizes from ½ to 100 hp. Housing is designed to prevent oil leakage, to keep dust and dirt from filtering into the unit, and to form a neat, compact drive for use whenever vertical driving is required.

High-Speed Gear Units

FOR CONNECTION to a steam turbine or for any other purpose where the speed of the pinion shaft is over 1800 r.p.m., the Farrel-Birmingham Co., Inc., Buffalo, N. Y., has developed and standardized a series of gear units suitable for speeds up to 6000 r.p.m. and powers from 120 hp. to 2500 hp., with ratios up to 10 to 1, for either increasing or reducing speed.

In the illustration the cover is removed to show the gears, which are the Farrel-Sykes herringbone continuous tooth type. A complete lubrication system is provided, together with an oil cooler consisting of a coil of copper pipe placed in the bottom of the gear case. The inlet and outlet pipes can be seen in the illustrations.

This new series of gear units is especially adapted, according to the manufacturer, for connecting Diesel or

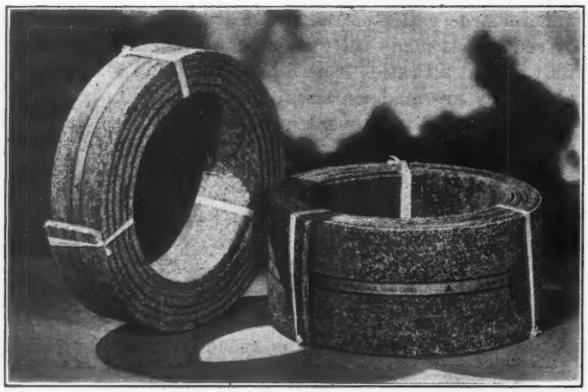


GEAR UNIT FOR SPEEDS UP TO 6000 R.P.M.

gas engines to centrifugal pumps. The latter are designed to operate at speeds ranging from 1200 r.p.m. to 3600 r.p.m. and the larger engines usually operate at speeds from 225 r.p.m. to 600 r.p.m.

Industrial Brake Lining

BRAKE LINING designed for every industrial requirement such as machinery used in sugar refineries, lumber mills, steel and tubing mills, paper mills, mines, and the like has recently been placed on the market by the Garlock Packing Co., Palmyra, N. Y. This is known as Garlock 701 folded and molded brake lining. It is also particularly applicable, according to the manufacturer, to steam shovels, ditchers, hoists and derricks, cranes, drag lines, elevators, car pullers and similar equipment.



GARLOCK 701 BRAKE LINING

This brake lining is constructed of high quality asbestos cloth, impregnated with a special rubber compound, then folded and molded and vulcanized under 2000 lb. pressure. It is made in widths from 1¼ in. to 12 in. and in thicknesses from 5/32 in. to 1 in.

New Packing Withstands Severe Service

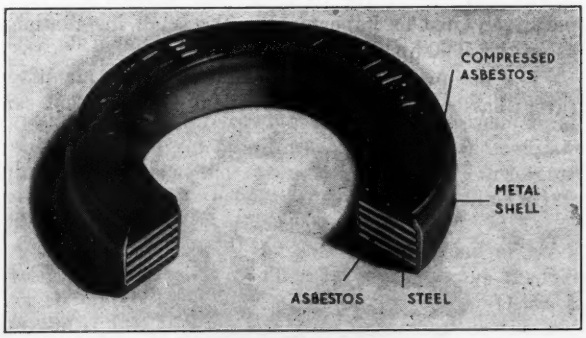
THE DIAMOND RUBBER Co. of Akron, O., announces a new product, known as "Rubber Crimps", or "U" Type Hydraulic Packing, for service on hydraulic rams and presses. The new packing is made in rings of standard sizes, with a U-shaped cross section. The rubber is especially compounded to resist oil, completely eliminating this source of trouble. It is covered almost completely with a layer of fabric, which adds considerable strength and helps to maintain the ¼-in. flare at the bottom. When there are worn or imperfect parts in the ram, the rubber packing with its flare works much more satisfactorily than any other kind.

This packing has the following important advantages: Very low cost; suitable for use with pressures up to 3000 lb. and more; not affected by the heat generated in an hydraulic press; wears very slowly and evenly; it fits snugly against the ram at all times, making absolute seal, even when the ram is imperfect; thickness vertically through center is ¾ in.—twice that ordinarily used, which serves to stiffen the flare and increase the strength and life of the packing; will not dry up when a press is idle; ideally adapted for all sizes of rams and can be furnished in any standard diameter.

Improved Valve Disc

FOR USE on all renewable-disc type valves, the improved valve disc shown in the accompanying illustration has recently been placed on the market by Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

As shown in the illustration, this valve disc consists of alternate cushions of asbestos and steel, incased in a metal shell. Compressed asbestos is exposed on top of the disc to insure tightness against the disc holder. The metal side of the disc faces the valve seat.

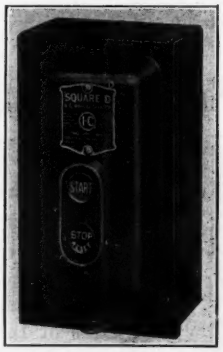


DETAILS OF CONSTRUCTION OF GOETZE IMPROVED VALVE DISC

These discs are made from either copper or monel metal and are recommended by the manufacturer for air, water, steam, chemicals, diluted acid, oil and similar materials. Discs of special metal, such as aluminum or stainless steel, can also be furnished.

Manual Starter

INDUSTRIAL CONTROLLER DIVISION of the Square D Co., Milwaukee, Wis., announces Class 2510 W5, a compact and rugged manual starter. This three-pole starter



MANUAL STARTER FOR PUSH BUTTON OPERATION

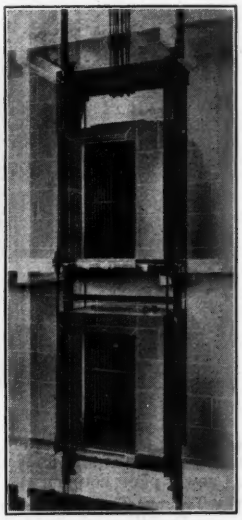
is designed to control across-the-line single and polyphase motors of 2 hp. or less. Although particularly adapted to fan, blower, pump, air compressor, machine tool and loom installations, it is suitable for general applications where remote control and low voltage protection are not essential.

It is built for push button operation, low price and compactness without sacrificing wiring space. Overload protection is provided by time limit thermal relays which are front reset and require no replacement of parts after operation, it is claimed. Tripping of either

relay opens all three lines. The starter is arranged for wall or pedestal mounting. Approximate dimensions of the starter are: width 4½ in., height 7¼ in. and depth 3¾ in.

Double-Deck Elevators for Cities Service Bldg.

FOR THE FIRST TIME in the history of building construction double-deck elevators have been installed in a skyscraper. The building in question is the new 67-story home of the Henry L. Doherty and Cities Service Co. at Cedar, Pine and Pearl Sts. in the heart of



PHANTOM VIEW OF DOUBLE-DECK ELEVATORS

New York's downtown financial district. In the Cities Service Building, eight high-rise, double-deck Otis elevators will serve all floors from the 29th to the 63rd, the lower floors being served by seven cars running from the 16th to the 29th, and the remaining lower floors by eight others. In addition, another innovation in office building transportation has been installed—escalators to handle the rush hour crowds between the 6th floor and the basement.

The double-deck elevator, developed by Otis Elevator Co., consists of two separate compartments mounted in a single car frame, or more simply a two-story car. It will be driven by a single hoisting engine and controlled basically in the same manner as the standard signal control elevator. Both compartments are loaded at the same time, one from the ground floor and the upper one from the first floor. Passengers are discharged at the upper floors at the same time, one compartment serving only the odd or even-numbered floors and the other only the alternate floors.

Each compartment has a capacity of 2500 lb., each is equipped with the standard signal control operating devices and each is operated by an attendant. Trap doors are installed to permit emergency access between compartments, and speaking tubes are provided for easy communication between compartments. During the night, when transportation requirements are reduced to almost nothing, a single remote-control switch will permit all double-deck elevators to be run as single decks. At such times, all operating devices are effective from one compartment only.

Special operating devices were required to coördinate the starting and stopping movements of the two cabs. The elevator will start only when the operating handles of both compartments are in the full "start" position and all car and hatchway doors are closed. By the same automatic devices which stop single-deck cars at floor level, the floors of both cabs will stop level with the desired floors in the double-deck system. The doors of both cabs will not open, however, unless calls have been registered for both floors at which the car stops. For instance, if the button for the 48th floor has been pushed and the button for the 49th floor has not been pushed, only the door of the lower cab will open when the car stops at these levels.

If, however, the hall button for the 49th floor is pushed before the operating handle in the lower compartment has been set in the full start position, the hall light on the 49th floor will light immediately, and the doors of the upper compartment will open. If the start has been initiated before the button on the 49th floor has been pushed, the call will be transferred to the next elevator approaching the floor in the desired direction.

To keep the operators of each cab informed about the activities in the other cab, a door pilot light is provided in the operating box of each compartment. The light is illuminated when the doors of the other cab are open and is extinguished when they start to close. The timing devices for these coördinating movements have been perfected, it is claimed, to such an extent that there is no possibility of accident from open doors. As an additional precaution, a car safety switch has been installed in both compartments, operating of which immediately stops the elevator.

The frame supporting both compartments has an over-all height of 25 ft. Any one of the eight special steel traction hoisting ropes is more than capable of carrying the combined weight of both compartments, each carrying its full rated load of 2500 lb. plus the weight of the frame. Clamp car safeties, consisting of two sets of powerful rail-gripping jaws, are mounted at both the top and bottom of the car-safety frame.

The architects for the Cities Service Building were Clinton & Russell, and Holton & George. James Stewart & Co. was the builder.

Improved Insulation Support

TO CORRECT pipe insulation disalinement and distortion and increase transmission efficiency, the American District Steam Co., North Tonawanda, New York, has designed a new insulation support to hold the pipe covering permanently concentric with the pipe. To prevent the weight of the insulation plus the weight of accumulated moisture from gradually causing the covering to sag away from the pipe at the bottom and pull thin on top, reducing the insulating effectiveness of the covering, the Adsco insulation support has been designed to eliminate these disadvantages. With this new support, the pipe covering is cradled in wide brass bands. Each band is hung from a saddle which passes through the insulation and rests directly on the upper surface of the pipe.

The company advises that the new insulation supports are available in all standard pipe sizes up to 24 in., and for 1½-in., 2-in. and 3-in. covering.

A. S. M. E. Annual Meeting at New York, Nov. 30 to Dec. 4

FOR THE ANNUAL meeting of the American Society of Mechanical Engineers to be held at the Society headquarters, 29 W. 39th St., New York, N. Y., November 30 to December 4, 1931, a varied program of technical papers and entertainment has been provided. The meeting opens on November 30, 1931, at 9:00 a.m.

At 2:00 p.m. simultaneous sessions will be held dealing with applied mechanics, metal cutting and fluid meters. Papers in the fluid meters meeting are as follows: Study of Primary Metering Elements in 3-in. Pipe, by Beitler, Bucher and Barnes; Flow of Steam Through Square-edge Orifices in 4-in. Line, by Frymoyer and Herschel; Reports from sub-committees on Revision of Part I, Description of Flow Meters and Water Meters, and Influence of Installation.

On Tuesday, December 1, sessions on casting and machine design, industrial power, applied mechanics and railroads and lubrication research will occupy the morning session beginning at 9:30.

In the Industrial Power session the following papers will be presented: Ford Motor Co.'s 1200-lb. Steam Plant Installation, Smith and Hanson; Characteristics of a High Pressure Series Steam Generator, Potter, Solberg and Hawkins; Once-Through Series Boiler for 1500 to 5000 lb. Pressure, Kerr; also a report of the power division.

On Wednesday, December 2, simultaneous sessions will be held at 9:30 a.m. on textiles, fuels, stabilization symposium, hydraulics. Among the papers in these sessions will be Fluxing of Ashes and Slags as Related to the Slagging Type of Furnace, Nicholls and Reid; Report of Fuels Division; Business Stabilization Symposium. In the hydraulic session will be papers on—Progress Report of the Hydraulic Division, Hydraulic Butterfly Valves, Mahon; and Piezometer Investigation, Allen and Hooper. At 2:00 p.m. Progress Reports on Steam Tables will be made by L. B. Smith, F. G. Keyes, N. S. Osborne and Harvey N. Davis.

There will also be another session on Lubrication Engineering and a second Hydraulic session including papers on Leakage Loss and Axial Thrust in Centrifugal Pumps, Stepanoff; Turbulence in Centrifugal Pumps, MacMeeken.

On Thursday, December 3, in the Central Station Power session, papers listed are: Performance of Modern Steam Generating Units, Hirschfeld and Moran; Solubility of Calcium Salts in Boiler Water, Straub; Influence of Inlet Boxes on the Performance of Induced Draft Fans, Marks and Winzenburger.

On Thursday afternoon at 2:00 p.m. the Oil and Gas Power session includes the following papers: Small Marine-Diesel Installations, Jackson; United States Navy Diesel-Engine Requirements, Commander Holbrook Gibson; Diesel Award, and Progress Report of Oil and Gas Power Division, L. R. Ford. A session on Boiler Feedwater Studies includes a paper on Determination of Carbonate Hydroxide and Phosphate in Boiler Waters, Progress Report of Sub-Committee No. 8, Schroeder and Fellows; Foaming and Priming of Boiler Water, Foulk; The SO_4/CO_3 Ratio for the Prevention of Sulphate Boiler Scale, by Partridge, Schroeder and Adams.

News Notes

ANNOUNCEMENT has just been made by the Worcester Salt Co., New York City, that it is carrying on the reconstruction of a boiler at its Silver Springs Refinery, Silver Springs, Wyoming County, New York. This work involves extensive changes in building, foundation and super-structure, from designs by the owner. Contracts have been awarded and work was scheduled to start October 15, 1931. The total estimated cost is $40,000.

The work included revamping a 1000-hp. boiler for ultimate operation at 400 lb. steam pressure. Water walls and superheater are to be of the Riley-Badenhausen type supplied by the Riley Stoker Corp. with air-cooled refractory settings supplied by American Arch Co. B. F. Sturtevant Co. induced and forced draft fans driven by Terry steam turbines will also be installed.

H. L. ROBINSON was appointed general sales manager of the Foster Wheeler Corp., New York City, effective September 1, 1931. Mr. Robnson has been associated for a long time with Foster Wheeler interests, having joined the Wheeler Condenser

and Engineering Co. prior to the formation of Foster Wheeler Corp. His work has included negotiations on large oil refinery contracts, as well as power plant equipment.

DEDICATION of the Thomas Duncan Memorial Addition to the Electrical Engineering Building of Purdue University, Lafayette, Ind., took place on Thursday, November 5, 1931, at 4:00 o'clock. The organizations coöperating in this dedication were the Duncan Electrical Manufacturing Co.; Engineering Section, Great Lakes Division, National Electric Light Association; Indianapolis-Lafayette Section and the Purdue University branch of the American Institute of Electrical Engineers and the Indiana Telephone Association.

PRECISION Rotary Pumps in new series, known as the XD series, have been placed on the market as the next larger size to the first group of XA pumps, built of nitralloy steel. Capacity range of the XD series is from 1 g.p.m. to 15 g.p.m. Two types of bearing construction are available. Nitralloy bearings for supporting the pump shafts are used in pumps for handling fuel oil, gas oil, glucose, coolant, peanut butter or any other liquid with little or no lubricating value. Roller bearings are incorporated in the XD pumps to be used for handling clean lubricating oil, especially for high pressure conditions, such as 1000 lb. They are made by Northern Pump Co., Minneapolis, Minn.

MERGER of the George W. Moore Co., of Chicago, with H. W. Caldwell & Son Co., a subsidiary of Link-Belt Co., is announced by Alfred Kauffmann, President, Link-Belt Co. The combined units are to be known as The Caldwell-Moore Division, Link-Belt Co.

Max H. Hurd, formerly President of the George W. Moore Co. becomes a Vice President of Link-Belt Co., in charge of the Caldwell-Moore operations, with headquarters at 2410 W. 18th Street, Chicago. Mr. Kauffmann states: "There will be no modification of the policies of the two companies and no change in the diversity and character of products."

ANNOUNCEMENT is made by the Mundet Cork Corp. that its New York office has been moved from the old address, 461 Eighth Ave., to new and larger quarters at 450 Seventh Ave., New York City.

DR. EDWARD R. WEIDLEIN, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced the foundation of an Industrial Fellowship by the Green Bag Cement Co. of Pittsburgh, subsidiary of the Davison Coke and Iron Co. The investigational work of this Fellowship, which will be carried on by Raymond C. Briant, will be concerned with studies of the chemical and physical properties of portland cement and with the de-

velopment of certain new cement products. Mr. Briant has come to Mellon Institute from the United States Bureau of Standards, Washington, D. C., where, during the past several years, he has been engaged in research under the auspices of the Portland Cement Association. He was previously employed in the portland cement industry of eastern Pennsylvania, following the completion of his chemical engineering education at Lafayette College.

BUSINESS of the American Zeolite Corp. was acquired October 1, 1931, through stock ownership by the General Water Treatment Corp. The business will be operated by the American Zeolite Corp. as a unit of the General Water Treatment Corp. with offices at 440 Fourth Ave., New York.

COMPREHENSIVE DISCUSSION of methods for testing oxy-acetylene welded joints will be a feature of the thirty-second annual convention of the International Acetylene Association at the Congress Hotel, Chicago, November 11, 12, and 13.

At the weld-test session, November 11 at 8:15 p.m., Professor H. L. Whittemore of the United States Bureau of Standards will speak on the importance of tests to welders and to users and makers of welded products. There will be a dramatized demonstration of visual and stethoscopic tests; hammer, bending, tension and hardness tests; invisible-ray tests; specific gravity, compression and internal pressure tests.

Other sessions will cover important fields where oxy-acetylene welding is used, opening on November 11 at 2:00 p.m.

At 2:30 p.m., November 12, welded piping for heating, water and air-conditioning systems; overland oil and gas lines; and the use of special fittings for welded installations will be discussed; November 13 at 10:00 a.m., high-pressure, high-temperature chemical piping; methods of welding the new corrosion-resisting alloys; and welded power piping. Charles Gorton, chairman of the Uniform Boiler Law Society, will explain the use of gas welding under the revised A. S. M. E. Boiler Code.

Admission to all sessions of the convention is free and anyone interested may obtain tickets at the convention headquarters in the Congress Hotel or from the International Acetylene Association, 30 East 42nd St., New York.

CP QUARTER CENTURY ASSOCIATION was formed October 1, 1931, to include all present employes of Chicago Pneumatic Tool Co. and its affiliates in its several manufacturing plants and numerous offices throughout the world, who have completed 25 yr. or more of uninterrupted service. Seventy-five were eligible at that time and their total years of service numbered 2,112. A suitably engraved certificate of Membership and a specially designed solid gold pin was presented to each member. The active male employe with the longest term of service in the United States is Louis H. Brueggemann, now employed at the Detroit, Michigan, plant and whose service dates from April, 1898. In foreign countries, the active male employe having the longest term of service is Horace P. Marshall, present manager of Leeds, England, office whose service dates from April, 1896. The active woman employe in the United States having the longest term of service is Miss Florence Aldcorn of the New York sales office, whose service dates from March, 1900. In foreign countries, the active woman employe having the longest term of service is Miss David of the Cardiff, Wales, office whose service dates from September, 1905. As others become eligible, they will be enrolled in the Association and presented with the Membership Certificate and pin.

PITTSBURGH STEEL PRODUCTS Co., a division of the Pittsburgh Steel Co., is taking advantage of the present depression to launch a program of expansion in its manufacturing facilities.

As a first step in this program, it has announced the purchase from The Aetna Standard Engineering Co., Youngstown, Ohio, of a complete new unit of the push bench type. This method is designed to produce tubes of extremely small diameters by the hot rolled reducing process; these sizes formerly could be produced only by the cold-drawing method.

DANA HARLAND has been appointed to direct sales of its new AE fuse by the Associated Engineers Co., Chicago, Ill.

STOKER MANUFACTURERS' ASSOCIATION held its annual meeting October 26-28 at Seaview Golf Club, Absecon, N. J. J. G. Worker, president, called attention to the social effects of the increasing use of stokers, including reduction of smoke and sulphur dioxide discharged into the atmosphere, improvement in boiler room working conditions and personnel and changes in the coal mining industry as the result of the creation of new markets for the sizes of coal fired by the smaller stokers.

T. A. Marsh forecast the development of heat service in metropolitan areas by companies that would install small stokers and supply complete service to operate them. It will be as easy, he said, to keep the stoker hoppers filled and remove the ashes as it is to ice a refrigerator in the home. John Lovett, general manager of the Michigan Manufacturers' Association, was guest speaker.

FAIRFIELD ENGINEERING Co., Marion, Ohio, in order to increase its services to users of coal and ash handling equipment, now manufactures a complete line of skip hoists and accompanying equipment. These skip hoists are now available in capacities from 4 to 300 t. an hour with bucket sizes from 10 to 150 cu. ft. and with bucket speeds ranging from 50 to 300 ft. per min. These skip hoists are built with unbalanced, counterweighted, or balanced type buckets and with either full-automatic or semi-automatic control. To meet every condition of service, the company builds two distinct types of skip loaders: the weight operated type automatically controlled by material weight and the bucket operated type designed for general purpose work.

CHATARD AND NORRIS, 218 Water St., Baltimore, Md., have just been appointed exclusive representative of Homestead Valve Manufacturing Co., Coraopolis, Pa., for the eastern part of Maryland and the District of Columbia.

HARRY S. SLEICHER, formerly vice president of the North American Refractories Co., has severed his connection with that company and is now associated with the General Refractories Co. in a sales capacity, with headquarters in the New York office of the latter company.

Catalog Notes

THE IDEAL ELECTRIC & MANUFACTURING Co. of Mansfield, Ohio, has available its new bulletin No. 512 giving details of the recently developed Ideal Synchronizing Alternators and their control and the application of these alternators to twin engines on twin screw vessels to give increased smoothness of operation.

FOLDER ON Valve Values from the Edward Valve & Mfg. Co., E. Chicago, Ind., describes the use of light for testing alloy materials, the method of forging alloy seats and disks and use of Y check valves to simplify piping layouts.

FLEXIBLE COUPLINGS as made by the Morse Chain Co., Ithaca, N. Y., are described and illustrated in its 24-page Bulletin 47, showing various types and their uses.

TAYLOR FORGE FITTINGS for use in welded construction of piping systems are illustrated and described in Bulletin 31-1 of 32 pages issued by Taylor Forge & Pipe Works, Box 485, Chicago, Ill. The line includes plain and reducing elbows for 90 and 45 deg., tees, reducing nipples, flanges and bull plugs for pipe sizes from 1-in. to 12-in. in standard stock and in flanges up to 48-in. for high-pressure lines and to 72-in. for low-pressure work. Special sizes are made on specification and to order. The line is so designed that only plain circumferential welds are needed in fabricating any piping arrangement.

BROWN ELECTRIC FLOW METERS are completely described and illustrated in a recent 16-page, letter-size illustrated bulletin, catalog 2002, by the Brown Instrument Co., Philadelphia, Pa. This bulletin describes the latest developments in this line of electric flow meters which operate on the inductance bridge principle. A new development is the low-range manometer designed for sensitivity and accurate flow measurement on low differential pressures. Another new development is the high-pressure flow meter manometer designed for measuring the flow of liquids, vapors or gases under pressures up to 5000 lb. per sq. in. Details of the instruments and illustrations of their applications are given.

BELT USER'S BOOK containing rules, suggestions and information about leather belting has just been published in the form of an illustrated, 70-page bulletin by J. E. Rhoads & Sons, 35 N. 6th St., Philadelphia, Pa. This book is a revision of the 1929 edition, containing specific suggestions, rules, tables and charts, with the addition of new material dealing with short center drives, group drives and individual drives.

GAS WELDING AND CUTTING EQUIPMENT is described in the Blue "N" Gold catalog No. 31 just issued by Torchweld Equipment Co., 224 No. Carpenter St., Chicago, Ill.

BELTING, HOSE, PACKING and other mechanical rubber goods are described and illustrated in loose-leaf bulletin No. 31, just issued by Pioneer Rubber Mill, 345 Sacramento St., San Francisco, Calif.

ALCUNIC condenser tubing is described in detail by William D. Price, Chief Chemist and Metallurgist of Scoville Mfg. Co., Waterbury, Conn., in a recent illustrated, 20-page booklet issued by that company. Alcunic is an alloy of copper, nickel, aluminum and zinc and the bulletin describes its properties in detail, shows photo-micrographs of the crystal structure and contains test curves and tables of physical and chemical characteristics.

IMPROVED DESIGN of Beaver pipe tools is completely described and illustrated in a recent bulletin No. 32 just issued by the Borden Co. of Warren, Ohio. This is a condensed catalog, designed to show in extremely compact form all the information needed by the engineer regarding these tools. In the 8 letter-sized pages are described the Model A Beaver ½ to 2 in., ratchet stock, various types of die stocks, pipe cutters and a complete list of repair parts.

Power Plant Construction News

Ala., Cornelia—Common Council is said to be planning installation of pumping machinery and auxiliary equipment in connection with a new municipal waterworks plant, to develop a capacity of 500,000 gals. per day, reported to cost about $75,000. Robert & Co., Inc., Bona Allen Building, Atlanta, Ga., is engineer.

Ala., Huntsville—Indian State Oil Co. of Oklahoma, Inc., Oklahoma City, Okla., John W. Sappington, president, plans installation of electric power equipment in proposed oil refining plant at Huntsville, where site has recently been acquired, entire project reported to cost about $100,000.

Ariz., Safford—Arizona General Utilities Co., S. S. Cobb, manager, is considering extensions and improvements in local steam-operated electric power plant to cost close to $75,000, with equipment.

Calif., Covina—San Gabriel Valley Pre-Cooling & Icing Corporation, Covina, has plans under way for a new two-story and basement ice-manufacturing and pre-cooling plant, 100x325 ft. to cost over $250,000, with equipment. Gay Engineering Corporation, 2650 Santa Fe Avenue, Los Angeles, Calif., is engineer.

Calif., San Bernardino—Dry Refrigeration, Inc., H. E. Weiss, president, San Bernardino, plans installation of electric power equipment in proposed new dry ice-manufacturing plant on site near city, entire project reported to cost over $125,000. Stone & Webster Engineering Corporation, 601 West Fifth Street, Los Angeles, Calif., is engineer.

Calif., Upland—Upland Citrus Association, Upland, has plans under way for a new precooling plant to cost about $60,000, with equipment. W. W. Ache, 1616 Fourth Avenue, Los Angeles, Calif., is architect.

Conn., Willimantic—Board of Trustees, Windham County Memorial Hospital, plans construction of a new power house and mechanical laundry at institution, reported to cost more than $80,000. G. E. Taylor is chairman, building committee.

Ga., Augusta—Municipal Canal Commission has plans under way for electrification of old canal system, including installation of standby power plant, with 10,000 kw. Diesel engine-generator unit and auxiliary equipment. Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

Ind., Terre Haute—Terre Haute Malleable & Mfg. Co. is said to be planning installation of motors and other power equipment in connection with proposed rebuilding of portion of plant recently destroyed by fire with loss of about $40,000.

Ind., Warsaw—City Council has preliminary plans under way for a municipal electric light and power plant, reported to cost over $250,000, with distributing system.

Kan., Neodesha—Standard Oil Co. of Kansas plans installation of power equipment in connection with an expansion and improvement program at oil refinery at Neodesha, entire project to cost $250,000.

La., Monroe—Morehouse Ice Co., Inc., Ouachita National Bank Building, recently organized, is said to have plans under way for a one-story ice and refrigerating plant to cost about $25,000.

Mich., Grand Rapids—W. J. Breen Gravel Co., Grandville Road, Grand Rapids, plans installation of power equipment at proposed new sand and gravel plant, entire project to cost close to $100,000.

Minn., Duluth—Duluth Steam Corporation, Duluth, has plans nearing completion for a steam power plant at Commerce Street and Lake Avenue, for central steam heating service in downtown district, reported to cost close to $1,000,000, with equipment.

Miss., Starkville—City Council has called a special election to approve a bond issue of about $100,000, proceeds to be used for a municipal electric light and power plant. Plans are being prepared. E. R. Lloyd is mayor.

N. J., Salem—Mannington Mills, Inc., State Highway 45, near Salem, plans installation of motors and other electric power equipment in connection with proposed rebuilding of portion of floor covering mill, recently damaged by fire with loss reported at $75,000.

N. Y., Brooklyn—Empire Book Match Co., 184-86 North Eighth Street, is said to be planning installation of motors and other power equipment in connection with proposed rebuilding of portion of plant recently destroyed by fire with loss reported at close to $50,000.

N. Y., Myers—International Salt Co., 475 Fifth Avenue, New York, is said to be planning the installation of electric power equipment in connection with proposed rebuilding of portion of plant at Myers, recently damaged by fire with loss reported at close to $75,000.

N. Y., Syracuse—Delavan Corrugated Box Co., Inc., East Hiawatha Boulevard, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant recently destroyed by fire with loss reported over $100,000.

N. C., Canton—Champion Fibre Co., Canton, plans installation of electric power equipment in connection with an expansion and improvement program to cost close to $1,000,000. Reuben B. Robertson is president.

Ore., Medford—California-Oregon Power Co., Medford, has made application for permission to dispose of a bond issue of $4,000,000, portion of proceeds to be used for expansion and improvements in plants and system.

S. D., Rapid City—City Council is having plans completed and will take bids at once for a new sewage treatment plant to cost about $215,000, with machinery. W. H. Zolper is city engineer.

Texas, Abilene—West Texas Utilities Co., Abilene, plans extensions and improvements in Panhandle district, including new power lines, power substation facilities, meter installations, etc. Company engineering department is in charge.

Texas, Houston—H. W. Hartman, Gulf Building, Houston, head of the Hartman Interests, Inc., and associates plan installation of power equipment in proposed new oil refining plant on the Houston ship channel, as well as pumping machinery, pipe line equipment and other mechanical equipment for oil well service in oilfield district about 60 miles from refinery site. Entire project is reported to cost over $3,000,000. E. W. Hartman, same address, is interested in the project.

Va., Norfolk—Hampton Roads Shipbuilding Corporation, Bankers Trust Building, Norfolk, plans installation of motors and other electric power equipment in connection with proposed rebuilding of portion of plant, estimated to cost over $80,000.

Va., Suffolk—The Suffolk Peanut Co., Suffolk, is said to be planning installation of motors and other electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire with loss over $150,000.

Wash., Tieton—Tieton Cold Storage Co., Tieton, has plans for immediate construction of a one-story cold storage and refrigerating plant, 72 x 180 ft., to replace a unit recently destroyed by fire, estimated to cost about $65,000, with equipment. W. F. Hoyer is president.

W. Va., Fairmont—Owens-Illinois Glass Co., 965 Wall Street, Toledo, Ohio, plans installation of electric power equipment in connection with an expansion and improvement program at bottle manufacturing plant at Fairmont, entire project reported to cost more than $25,000; new stokers will be installed, and new coal bunkers constructed.

W. Va., Parkersburg—Viscose Co. of America, Inc., Marcus Hook, Pa., plans new boiler plant at rayon mill at Parkersburg, to use pulverized fuel, reported to cost over $30,000, with equipment. Ballinger Co., Twelfth and Chestnut Streets, Philadelphia, Pa., is architect and engineer.

Wis., Oconto—Common Council has recently concluded negotiations for acquisition of local plant and system of Oconto Power & Light Co., effective Jan. 1, and plans extensions and improvements, including installation of additional equipment, estimated to cost about $60,000. Gordon & Bulot, 53 West Jackson Boulevard, Chicago, Ill., are engineers.